RECLAMATION
Managing Water in the West

Draft Environmental Impact Statement

Navajo Generating Station-Kayenta Mine Complex Project

Text

The U.S. Department of the Interior protects America's natural resources and heritage, honors our cultures and tribal communities, and supplies the energy to power our future.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

United States Department of the Interior

BUREAU OF RECLAMATION
Lower Colorado Region
Phoenix Area Office
6150 West Thunderbird Road
Glendale, AZ 85306-4001

IN REPLY REFER TO:
PXAO-1500
ENV-6.00

Sept. 23, 2016

MEMORANDUM

To: All Interested Persons, Organizations, and Agencies

From: Leslie A. Meyers
Area Manager
Leslie A. Meyers

Subject: Notice of Availability of the Draft Environmental Impact Statement (EIS) for Public Review and Comment, and Schedule of Public Meetings, for the Navajo Generating Station–Kayenta Mine Complex (NGS-KMC) Project (Project) (Action by November 29, 2016)

The Bureau of Reclamation is issuing a *Federal Register* Notice of Availability of the Draft EIS on the proposed NGS-KMC Project on September 30, 2016. The Proposed Action in the EIS would provide Federal approvals and/or decisions necessary to continue the operation and maintenance of the NGS and associated facilities, the proposed Kayenta Mine Complex, and existing transmission systems for another 25 years, from December 23, 2019, through December 22, 2044, plus decommissioning.

The public review and comment period for the Draft EIS will be from September 30, 2016, through November 29, 2016. Comments received during the public review and comment period will be considered before the EIS is finalized and the Secretary of the Interior makes a decision about the Proposed Action. Public meetings are scheduled to occur from October 24, 2016, through November 4, 2016, (details of these meetings are provided later in this memorandum). This copy of the Draft EIS is included for your information and use.

The Draft EIS also is available for review or download on the Project website: http://www.NGSKMC-EIS.net. Additional information, including supplemental materials will be available on the project web site, as well.

A hard copy of the Draft EIS is available for public review and inspection at the following locations:

- Bureau of Reclamation, Phoenix Area Office, 6150 West Thunderbird Road, Glendale, Arizona.
- Natural Resources Library, U.S. Department of the Interior, 1849 C Street NW, Main Interior Building, Washington, DC.
- Bureau of Indian Affairs, Navajo Regional Office, 301 West Hill Street, Gallup, New Mexico.
- Office of Surface Mining and Reclamation Enforcement, Western Regional Office, 1999 Broadway Street, Suite 3320, Denver, Colorado.
- Glen Canyon National Recreation Area Headquarters, 691 Scenic View Road, Page, Arizona.

- Casa Grande Public Library, 449 North Drylake Street, Casa Grande, Arizona.
- Hopi Tribal Headquarters, Main Lobby, 123 Main Street, Kykotsmovi, Arizona.
- Navajo Nation Library, Highway 264 and Postal Loop Road, Window Rock, Arizona.
- LeChee Chapter House, 5 miles south of Page off of Coppermine Road, LeChee, Arizona.
- Tuba City Chapter House, 220 South Main Street, Tuba City, Arizona.
- Shonto Chapter House, East Navajo Route 221, Shonto, Arizona.
- Kayenta Chapter House, Highway 163, Kayenta, Arizona.
- Forest Lake Chapter House, 17 miles north of Pinon on Navajo Route 41, Pinon, Arizona.

Reclamation is holding 11 open-house meetings to give the public an opportunity to ask questions about the Draft EIS and provide your comments on what you think is missing from, or not properly evaluated in, the EIS. Members of the public may arrive at any time during each open-house meeting; there will be an informal presentation one-half hour after the meeting begins. Project team members will be available to provide information and answer questions about the Draft EIS. Written comments will be accepted at the meetings, and court reporters will be present at all meetings to record oral comments. Navajo and Hopi interpreters will be present at the open-house meetings as noted. The open-house meeting schedule is as follows:

1. Monday, October 24, 2016, 10 a.m. to 1 p.m., Burton Barr Central Library, Pulliam Auditorium, 1221 North Central Avenue, Phoenix, Arizona.
2. Monday, October 24, 2016, 5 p.m. to 8 p.m., Dorothy Powell Senior Adult Center, Dining Room, 405 East Sixth Street, Casa Grande, Arizona.
3. Tuesday, October 25, 2016, 4 p.m. to 7 p.m., Page Community Center, Cafeteria, 699 South Navajo Drive, Page, Arizona. (Navajo interpreters present).
4. Wednesday, October 26, 2016, 9 a.m. to 12 p.m., LeChee Chapter House, 5 miles south of Page off of Coppermine Road, LeChee, Arizona (Navajo interpreters present).
5. Wednesday, October 26, 2016, 4 p.m. to 7 p.m., Tuba City Chapter House, 220 South Main Street, Tuba City, Arizona (Hopi and Navajo interpreters present).
6. Thursday, October 27, 2016, 10 a.m. to 1 p.m., Shonto Chapter House, East Navajo Route 221, Shonto, Arizona (Navajo interpreters present).
7. Tuesday, November 1, 2016, 4 p.m. to 7 p.m., Monument Valley High School, Cafeteria, Highway 163 and Monument Valley Boulevard, Kayenta, Arizona (Navajo interpreters present).
8. Wednesday, November 2, 2016, 10 a.m. to 1 p.m., Tewa Community Center, Multipurpose Room, Highway 264 at Milepost 392.8, Polacca, Arizona (Hopi and Navajo interpreters present).
9. Wednesday, November 2, 2016, 4 p.m. to 7 p.m., Hopi Day School, Gym, ¼ mile east of the Village Store on Main Street, Kykotsmovi, Arizona (Hopi and Navajo interpreters present).

10. Thursday, November 3, 2016, 10 a.m. to 1 p.m., Forest Lake Chapter House, 17 miles north of Pinon on Navajo Route 41, Pinon, Arizona (Navajo interpreters present).
11. Friday, November 4, 2016, 10 a.m. to 1 p.m., Navajo Nation Museum, Conference Room, Highway 264 and Postal Loop Road, Window Rock, Arizona (Navajo interpreters present).

If special assistance is required at a public meeting, please contact Ms. Tania Fragomeno at 858-926-4022, or email your assistance needs to NGSKMC-EIS@usbr.gov, along with your name and telephone number. Please indicate your needs at least two (2) weeks in advance of the meeting to enable Reclamation to secure the needed services. The requestor will be notified if a request cannot be honored. The public is encouraged to submit comments by the deadline of November 29, 2016. Regardless of whether you are able to participate in the open-house meetings, you may send written comments via postal mail, hand delivery, or courier to:

NGS-KMC Project Manager, PXAO-1500
Bureau of Reclamation, Phoenix Area Office
6150 West Thunderbird Road
Glendale, AZ 85306-4001

You also may fax your comments to 623-773-6483 or email your written comments to NGSKMC-EIS@usbr.gov. To ensure comments are considered in the preparation of the Final EIS, they must be postmarked by the end of the comment period on November 29, 2016.

Before including your address, phone number, email address, or other personal identifying information in your comment, you should be aware that your entire comment – including your personal identifying information – may be made publicly available at any time. While you can ask us in your comment to withhold your personal identifying information from public review, we cannot guarantee that we will be able to do so.

For more information regarding the EIS, please visit the Project website at http://www.NGSKMC-EIS.net, or call Ms. Sandra Eto, at 623-773-6254.

Attachment

DRAFT ENVIRONMENTAL IMPACT STATEMENT
NAVAJO GENERATING STATION-KAYENTA MINE COMPLEX PROJECT

Lead Agency: Department of the Interior, Bureau of Reclamation

Cooperating Agencies:
Department of the Interior
- Bureau of Indian Affairs
- Office of Surface Mining Reclamation and Enforcement
- Bureau of Land Management
- National Park Service
- U.S. Fish and Wildlife Service

U.S. Environmental Protection Agency
U.S. Department of Agriculture, Forest Service
Navajo Nation
Hopi Tribe
Gila River Indian Community
Pueblo of Zuni
Arizona Game and Fish Department
Central Arizona Water Conservation District

For further information regarding this Draft Environmental Impact Statement, visit http://www.ngskmc-eis.net or contact:

Ms. Sandra Eto
Bureau of Reclamation
6150 W. Thunderbird Road
Glendale, AZ 85306-4001
ngskmc-eis@usbr.gov
(623) 773-6254

Comments should be received by November 29, 2016

Filing Date: September 23, 2016

ABSTRACT

The Navajo Generating Station (NGS) is an existing 2,250-megawatt (MW) coal-fired power plant located on leased Navajo Nation tribal trust lands about 5 miles east of Page, Arizona. NGS provides baseload power to over 1 million customers in Arizona, California, and Nevada. NGS also provides over 90 percent of the power used by the Central Arizona Project (CAP), a federal Bureau of Reclamation (Reclamation) project that delivers approximately 1.5 million acre-feet annually of Colorado River water from a diversion point in Lake Havasu near Parker, Arizona, to tribal, agricultural, municipal, and industrial water users in Maricopa, Pinal, and Pima counties, Arizona. Reclamation is authorized to sell its share of NGS power, which is in excess to the needs of the CAP, at market rates. The revenues from the sale of this surplus power are deposited into the Lower Colorado River Basin Development Fund (Development Fund). The Development Fund is used to assist in the annual repayment of construction costs for the CAP, and for the payment of fixed operation, maintenance, and replacement charges associated with the delivery of CAP water to Arizona Native American tribes, as well as other statutory purposes.

The coal supply for the NGS is delivered from Kayenta Mine, located about 78 miles southeast of NGS. The Kayenta Mine is the sole commercial supplier of coal used by the NGS and NGS is the sole commercial customer of coal produced at the Kayenta Mine. The Kayenta Mine is located on Navajo and Hopi trust lands, on which three contiguous mining leases have been granted to Peabody Western Coal Company.

Together the Navajo lease for the NGS and its associated facilities and the Navajo and Hopi coal mining leases have provided both the Navajo and Hopi tribes with substantial revenues from lease and coal royalties that support the Navajo and Hopi governments.

This Draft Environmental Impact Statement (EIS) evaluates the environmental impacts that would result from the continued operation and maintenance of the NGS and associated facilities, the proposed Kayenta Mine Complex (KMC), and existing transmission systems, from December 23, 2019 through December 22, 2044, plus decommissioning of the facilities and reclamation of the land (the Proposed Action). Three action alternatives are evaluated in the EIS. Each action alternative would provide for partial replacement of the federal portion of NGS power, but would require continued operation of the NGS and proposed KMC to supply the remaining power required to run the CAP pumps and provide excess power for sale at market rates to generate funds that would be deposited to the Development Fund. A No Action Alternative also is evaluated in which approvals would not be granted. NGS decommissioning activities would begin in 2018 with effective shutdown of the power plant occurring by the end of 2019. Coal mine reclamation is assumed to begin in 2019 and would continue for 10 to 15 years until final bond release.

Additional project-related materials are available for viewing or download at http://www.NGSKMC-EIS.net/.

Executive Summary

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Acronyms and Abbreviations

1969 Lease	Navajo Project Indenture of Lease
BART	Best Available Retrofit Technology
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BM&LP Railroad	Black Mesa & Lake Powell Railroad
BO	Biological Opinion
CAP	Central Arizona Project
CAWCD	Central Arizona Water Conservation District
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CO_2	carbon dioxide
Co-tenants	Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
Development Fund	Lower Colorado River Basin Development Fund
EIS	Environmental Impact Statement
ERA	Ecological Risk Assessment
ESA	Endangered Species Act of 1973
HHRA	Human Health Risk Assessment
km	kilometer
KMC	Kayenta Mine Complex
kV	kilovolt
kW	kilowatt
MW	megawatt
N-Aquifer	Navajo Aquifer
NEPA	National Environmental Policy Act of 1969, as amended
NGS	Navajo Generating Station
NGS Participants	U.S. (Reclamation), Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
NHPA	National Historic Preservation Act
NNEPA	Navajo Nation Environmental Protection Agency
NO_2	nitrogen dioxide
NO_X	nitrogen oxide
OSMRE	Office of Surface Mining Reclamation and Enforcement
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 microns or less
PFR	Partial Federal Replacement
PWCC	Peabody Western Coal Company
Reclamation	U.S. Bureau of Reclamation
ROW	Right-of-way
SO_2	sulfur dioxide
SRP	Salt River Project Agricultural Improvement and Power District

STS	Southern Transmission System
U.S.	United States
USC	United States Code
USEPA	U.S. Environmental Protection Agency
WTS	Western Transmission System

Contents

ES1.0 Executive Summary ES-1
ES1.1 Introduction ES-1
ES1.2 Public Involvement/Scoping ES-1
ES1.3 Purpose and Need for the Proposed Action ES-3
ES1.4 Development and Description of Alternatives ES-9
ES1.4.1 Alternatives Considered but Eliminated from Detailed Analysis in the EIS ES-9
ES1.4.2 Alternatives Evaluated in the EIS ES-10
ES1.4.2.1 NGS-KMC Project (Proposed Action) ES-10
ES1.4.2.2 Natural Gas Partial Federal Replacement (PFR) Alternative ES-11
ES1.4.2.3 Renewable Partial Federal Replacement Alternative ES-11
ES1.4.2.4 Tribal Partial Federal Replacement Alternative ES-12
ES1.4.2.5 No Action Alternative ES-12
ES1.5 Primary Technical Issues ES-13
ES1.6 Affected Environment and Environmental Consequences ES-14
ES1.6.1 Affected Environment ES-14
ES1.6.2 Environmental Consequences ES-19

List of Tables

Table ES-1 Preliminary List of Federal Actions for the NGS-KMC Project ES-4
Table ES-2 Navajo Generating Station – Kayenta Mine Complex Project Quantitative Impact Summary ES-20
Table ES-3 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary ES-23

List of Figures

Figure ES-1 General Location Map ES-2

ES1.0 Executive Summary

ES1.1 Introduction

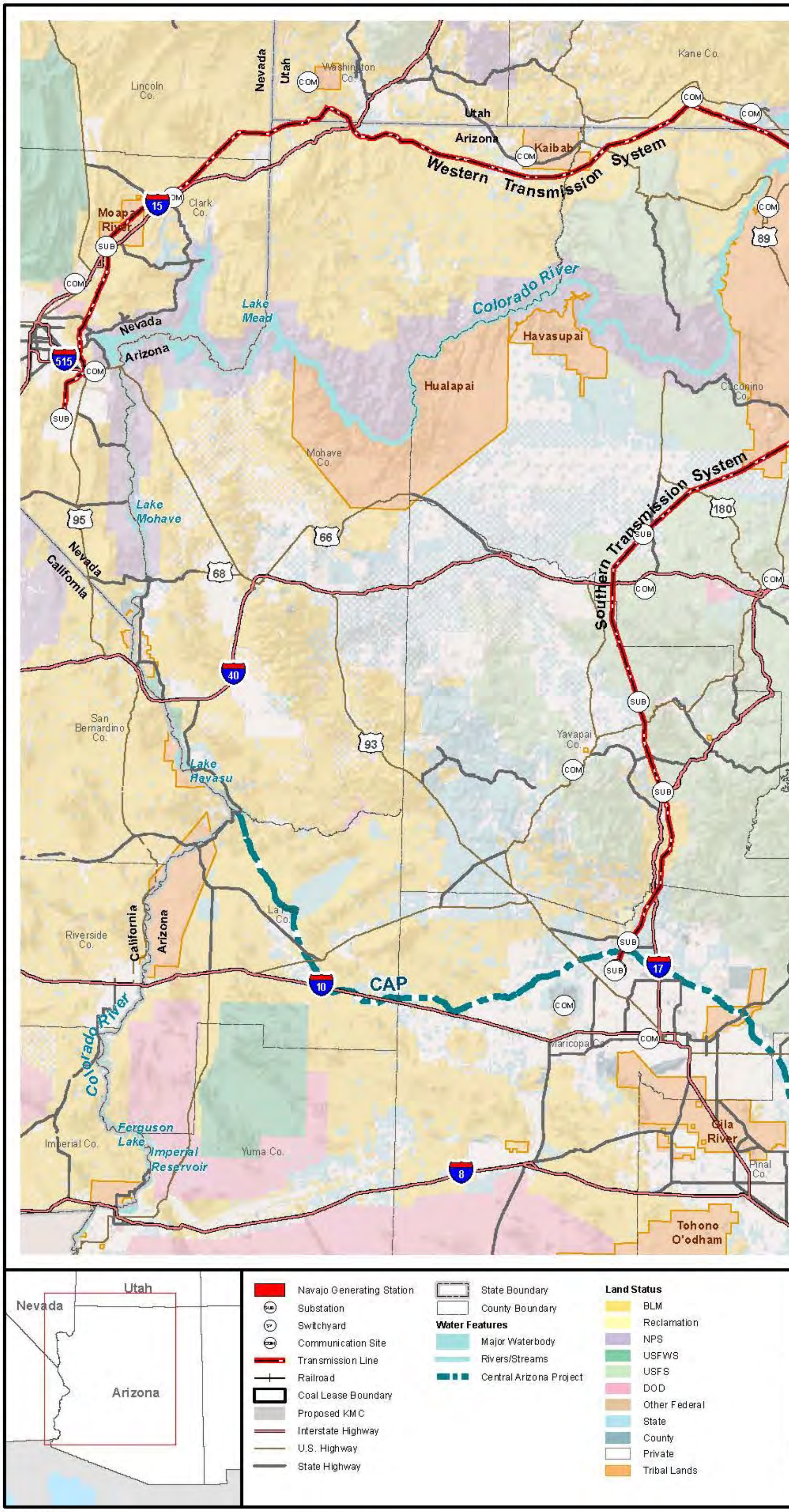
The Navajo Generating Station (NGS) is an existing 2,250-megawatt (MW) coal-fired power plant located on leased Navajo Nation tribal trust lands approximately 5 miles east of Page, Arizona. NGS provides baseload power to over 1 million customers in Arizona, California, and Nevada. NGS also provides over 90 percent of the power used by the Central Arizona Project (CAP), a federal project that delivers approximately 1.5 million acre-feet annually of Colorado River water from a diversion point in Lake Havasu near Parker, Arizona, to tribal, agricultural, municipal, and industrial water users in Maricopa, Pinal and Pima counties, Arizona. The current NGS Participants include the NGS Co-tenants (Salt River Project Agricultural Improvement and Power District (SRP), which also is the operator of NGS; NV Energy; and Tucson Electric Power Company), and the United States. Power generated by NGS is transmitted to points of delivery by the Western Transmission System (WTS) and Southern Transmission System (STS) and their associated substations and communication sites.

The coal supply for the NGS is delivered from Peabody Western Coal Company's (PWCC) Kayenta Mine, located approximately 78 miles southeast of NGS. The Kayenta Mine is the sole commercial supplier of coal used by the NGS, and NGS is the sole commercial customer of coal produced at the Kayenta Mine. The Kayenta Mine is located on the Black Mesa and on Navajo and Hopi trust lands, where PWCC has been granted three contiguous mining leases that provide PWCC the right to produce up to a total of 670 million tons of coal (**Figure ES-1**). Under the Proposed Action, facilities on the former Black Mesa Mine currently being used to support the Kayenta Mine operations would be combined with the existing Kayenta Mine to create the proposed Kayenta Mine Complex (KMC); mining would not be authorized anywhere in the former Black Mesa Mine area.

The terms of the Navajo Project Indenture of Lease for Units 1, 2, and 3 (1969 Lease) for NGS and its associated facilities and the Navajo and Hopi coal mining leases have provided both tribes with substantial revenues from lease and coal royalties, which support the Navajo and Hopi governments.

ES1.2 Public Involvement/Scoping

Formal Public Scoping was initiated when a Notice of Intent to prepare an Environmental Impact Statement (EIS) was published in the *Federal Register* on May 16, 2014; Public Scoping closed on August 31, 2014. Ten public scoping open house meetings were held June 10-June 20, 2014, in the following Arizona locations: Window Rock, Forest Lake, Kayenta, Shonto, LeChee, and Tuba City on the Navajo Reservation; Kykotsmovi on the Hopi Reservation; and Page, Phoenix, and Marana. An additional scoping open house meeting was held on Third Mesa of the Hopi Reservation on August 14, 2014, and two community outreach meetings also were held on the Hopi First and Second Mesas on August 13, 2014. At the request of residents living within the PWCC mine leasehold, two listening sessions were held at the PWCC Human Resources Center on July 16 and August 28, 2015. The residents provided input on cultural resources and other issues related to the Proposed Action.



Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure ES-1

General Project Location

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7/20/2016

ES1.3 Purpose and Need for the Proposed Action

The Secretary of the Interior (Secretary) proposes to approve the federal actions, which would enable continued involvement by the United States (U.S.) in the NGS beyond December 22, 2019, when the current lease between the NGS Co-tenants and the Navajo Nation is set to expire. There are a number of federal approvals and actions associated with the Proposed Action under the Secretary's authority (**Table ES-1**). The following are the major Secretarial approvals described in detail in the Environmental Impact Statement (EIS):

- As an NGS Participant, the U.S. Bureau of Reclamation (Reclamation) needs to respond to the impending expiration of the initial term of the 1969 Lease, grants of right-of-way (ROW) and easements, and other agreements needed for the continued operation of NGS. Reclamation's purpose for the Proposed Action is to secure, after 2019, a continuously available and reliable source of power and energy to operate the CAP pumps, which would be competitively priced with NGS and could be sold as surplus power, the proceeds of which would be deposited in the Lower Colorado River Basin Development Fund (Development Fund). Development Fund revenues are used to assist in repayment of CAP construction costs, and for the payment of fixed operation, maintenance, and replacement charges associated with the delivery of CAP water to Arizona Native American tribes and other statutory purposes.
- The Office of Surface Mining Reclamation and Enforcement (OSMRE) is responsible for carrying out the requirements of the Surface Mining Control and Reclamation Act (SMCRA) in cooperation with states and tribes. As the regulatory authority on Indian lands, OSMRE (Western Region) is responsible for ensuring that the operation of the proposed Kayenta Mine Complex (KMC) permit area would be in accordance with all SMCRA requirements, including all applicable environmental performance and reclamation standards. Accordingly, OSMRE needs to respond to PWCC's SMCRA Kayenta Mine permit revision application and proposed Life-of-Mine Plan and determine whether to approve, approve with special conditions, or disapprove the application in accordance with the requirements of SMCRA. OSMRE's purpose for the Proposed Action is to implement the environmental protections, reclamation standards, and other permitting requirements under SMCRA, while balancing the U.S.' need for continued domestic coal production with protection of the environment (see 30 United States Code [USC] Section 1202).
- The Bureau of Indian Affairs (BIA)-Navajo Region must decide, consistent with the requirements of 25 USC Section 415(a) and 25 Code of Federal Regulations (CFR) Part 169, and subject to the consent of the Navajo Nation, whether or not to approve: 1) the NGS Lease Amendment No. 1 (or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1) and 2) other grants of ROW issuances, amendments, or renewal(s) that would allow for the continued operation of the NGS and its associated facilities on Navajo Tribal trust land through December 22, 2044. BIA also must approve the proposed relocation of portions of Navajo Route 41 within the proposed KMC permit area on Navajo and Hopi surface lands.
- Each of the federal decisions at issue must be consistent with federal Indian policies including, but not limited to, a preference for tribal self-determination and promotion of tribal economic development for all tribes affected by these federal decisions. In addition, the federal government has a trust responsibility to protect and maintain rights reserved by, or granted to, Indian tribes and individuals by treaties, statutes, and executive orders.

Table ES-1 Preliminary List of Federal Actions for the NGS-KMC Project

Entity and Role in EIS	Approval Action – NGS and Associated Facilities, WTS, and STS	Approval Action – Proposed KMC
Federal Entities		
Reclamation Role: Lead federal agency for purposes of complying with the National Environmental Policy Act (NEPA), Section 7 of the Endangered Species Act (ESA), and Section 106 of the National Historic Preservation Act, Ensure adequate coordination with the key cooperating agencies, other cooperating agencies, and affected tribes as appropriate. Ensure EIS complies with the Council on Environmental Quality, U.S. Department of the Interior, and Reclamation NEPA requirements; review and approve project mitigation; ensure all information is adequate to issue a Record of Decision based on the Final EIS analysis. Conduct Government-to-Government consultations with affected tribes.	Approve or consent to contracts and other arrangements to extend the NGS Project operations through 2044, including but not limited to: • Amendment No. 1 to the Indenture of Lease between Navajo Nation and NGS Participants (or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1); • Land grants, easements, and ROWs; • Revisions to or new Co-Tenancy Agreement and other Navajo Project Agreements among the NGS Participants; and • Extension of the Coal Supply Agreement. Develop and approve terms of a renewal contract for water service from Lake Powell for operations through 2044 pursuant to Article 2 of the January 17, 1969, Water Service Contract; 1902 Reclamation Act (32 Statute 388) as amended; and 1956 Colorado River Storage Project Act Boulder Canyon (70 Statute 105), as amended. Issue a new license for the railroad crossing under the Glen Canyon Shiprock 230-kilovolt transmission line, Contract No. 14-06-400-5882 pursuant to the 1902 Reclamation Act (32 Statute 388), as amended. Issue new easement for a portion of the WTS pursuant to the 1902 Reclamation Act (32 Statute 388), as amended. Approve and provide funding in proportion to its Participant share in NGS of the actions required for the operation of NGS, WTS, and STS according to the project agreements and for eventual decommissioning.	Approve coal supply agreement between PWCC and NGS Co-tenants.

Table ES-1 Preliminary List of Federal Actions for the NGS-KMC Project

Entity and Role in EIS	Approval Action – NGS and Associated Facilities, WTS, and STS	Approval Action – Proposed KMC
OSMRE – Western Region Role: Act as key cooperating agency per Memorandum of Understanding among Reclamation, OSMRE, BIA, SRP, and PWCC. Review EIS regarding compliance with OSMRE requirements; ensure all information is adequate to issue a Record of Decision based on the Final EIS analysis. Participate in government-to-government consultations.	None	Approve a permit revision for: • Changes in the proposed KMC Life-of-Mine Plan; • Relocation of a public road; and • Adjustment of a permit boundary pursuant to Surface Mining Control and Reclamation Act to include existing support facilities (30 USC Section 1201 et seq.). Consult on potential impacts to cultural resources. Participate in ESA Section 7 consultation.
BIA – Navajo Region Role: Act as key cooperating agency per Memorandum of Understanding among Reclamation, OSMRE, BIA, SRP, and PWCC. Review EIS regarding compliance with BIA requirements; ensure all information is adequate to issue a Record of Decision based on the Final EIS analysis. Participate in government-to-government consultations.	Approve the NGS Project Lease Amendment No. 1 (or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1) pursuant to 25 USC Section 415(a) and 25 CFR Part 162. Approve renewed, amended, or new 323 Grants of ROW and easements for the NGS Project on Navajo Nation Indian Lands pursuant to 25 USC Section 323 and 25 CFR Part 169, including but not limited to: • Plant Site and associated facilities; • Railroad; • Coal Conveyor; • WTS; • STS; • Communication Sites; and • Moenkopi Switchyard. Approve actions by the Navajo Nation to take on an ownership interest in NGS pursuant to provisions contained in the Lease Amendment No.1 (or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1), should the Navajo Nation choose to do so. Consult on potential impacts to cultural resources. Participate in ESA Section 7 consultation.	Approve realignment of Navajo Route 41 pursuant to 30 CFR Part 761.14(b). Renew or issue new grants of ROW and easements for the NGS-KMC Project on tribal lands.

Table ES-1 Preliminary List of Federal Actions for the NGS-KMC Project

Entity and Role in EIS	Approval Action – NGS and Associated Facilities, WTS, and STS	Approval Action – Proposed KMC
BIA – Western Region Role: Act as cooperating agency per Memorandum of Understanding between Reclamation and BIA – Western Region. Participate in government-to-government consultations.	Approve or disapprove Pipe Spring communication site 323 Grant pursuant to 25 USC Section 323 and 25 CFR Part 169. Consult on potential impacts to cultural resources	
BIA Western Region – Hopi Agency Role: Review EIS regarding compliance with BIA requirements; ensure all information is adequate to issue a Record of Decision based on the Final EIS analysis.	None	Approve realignment of Navajo Route 41 pursuant to 30 CFR Part 761.14(b).
Bureau of Land Management (BLM) Role: Act as cooperating agency per Memorandum of Understanding between Reclamation and BLM.	Issue new Federal Land Policy and Management Act ROW grants for the STS and WTS across jurisdictional public lands in Arizona, Utah, and Nevada pursuant to Title V. Ensure use is administered consistent with Public Law 96-491 for segment through Moapa Reservation. Consult on potential impacts to cultural resources. Participate in ESA Section 7 consultation.	Approve changes to the proposed KMC Resource Recovery and Protection Plan (mining plan) pursuant to 25 CFR Part 216; 43 CFR Part 3480.
U.S. Army Corps of Engineers Role: Review the EIS for compliance with Clean Water Act regulations, if applicable.	None	As applicable, approve Section 404 permit modifications and a revision for the proposed KMC pursuant to the Clean Water Act 33 USC Section 1342; 33 CFR Parts 320, 323, 325.
U.S. Fish and Wildlife Service Role: Act as cooperating agency per Memorandum of Understanding between Reclamation and U.S. Fish and Wildlife Service.	As applicable, prepare and issue a Biological Opinion, pursuant to Section 7 of the ESA (16 USC Section 1531 et seq.). Ensure compliance with the Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act.	As applicable, prepare and issue a Biological Opinion, pursuant to Section 7 of the ESA (16 USC Section 1531 et seq.). Ensure compliance with the Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act.

Table ES-1 Preliminary List of Federal Actions for the NGS-KMC Project

Entity and Role in EIS	Approval Action – NGS and Associated Facilities, WTS, and STS	Approval Action – Proposed KMC
National Park Service Role: Act as cooperating agency per Memorandum of Understanding between Reclamation and National Park Service.	Renew or issue a new ROW permit to cover a portion of the underground water intake (tunnel) system that supplies water to NGS. The renewed or newly issued permit would replace ROW Permit No. RW GLCA-06-002, granted pursuant to 16 USC Section 79 and expiring in 2032, to cover the period until 2044. Renew a ROW for a portion of the WTS on the Glen Canyon National Recreational Area pursuant to 16 USC Section 5 and 36 CFR Part 14. Consult on potential impacts to cultural resources. Participate in ESA Section 7 consultation.	None
U.S. Environmental Protection Agency (USEPA) Role: Act as cooperating agency per letter dated May 28, 2014. Review EIS for compliance with applicable federal environmental regulations.	USEPA has delegated the Clean Air Action's Title V operating permit program under 40 CFR Part 71 to the Navajo Nation Environmental Protection Agency (NNEPA). NNEPA issued the current Part 71 permit for the Kayenta Mine, and PWCC has submitted a renewal application to NNEPA. Final approval of Clean Air Act Title V, 40 CFR Part 71, operating permit renewal currently is pending with NNEPA. Action on this permit renewal is anticipated to occur prior to 2020.	As applicable, approve National Pollution Discharge Elimination System permit modifications and a revision for the proposed KMC pursuant to the Clean Water Act (33 USC Section 1342); 40 CFR Part 124.9. If needed, approve Nationwide Stormwater Discharge Permit. USEPA has delegated the Clean Air Act's Title V operating permit program under 40 CFR Part 71 to the NNEPA. NNEPA issued the current Part 71 permit for the Kayenta Mine, and PWCC has submitted a renewal application to NNEPA.
U.S. Forest Service Role: Act as cooperating agency per Memorandum of Understanding between Reclamation and U.S. Forest Service.	Renew ROWs across the Kaibab and Prescott National Forests in Arizona originally granted pursuant to the Act of March 4, 1911 (36 Statute 1253, as amended by Public Law 307, 66 Statute 95). Consult on potential impacts to cultural resources.	None

Table ES-1 Preliminary List of Federal Actions for the NGS-KMC Project

Entity and Role in EIS	Approval Action – NGS and Associated Facilities, WTS, and STS	Approval Action – Proposed KMC
Non-federal Entities		
Navajo Nation Role: Act as cooperating agency per Memorandum of Understanding between Reclamation and the Navajo Nation. Participate in government-to-government consultations.	Review and approve the Clean Air Act Title V, 40 CFR Part 71, operating permit renewal application. The Navajo Nation will periodically (every 5 years) review and issue the permit. Government-to-government consultation with Reclamation on Section 7 of the ESA and special status species. Decide whether to execute the option to take on an ownership interest in NGS pursuant to provisions contained in the Lease Amendment No. 1. If needed, and as an alternative to Lease Amendment No. 1, approval of a new lease agreement among the Navajo Nation and the continuing NGS owners having similar terms as Lease Amendment No. 1. Consult on potential impacts to cultural resources.	Consult on potential impacts to cultural resources. Government-to-government consultation on Section 7 of the ESA and Special Status Species. Consult by performing a technical review of the Life-of-Mine application. Approve or disapprove Clean Water Act Section 401 water quality certifications, if needed. On behalf of USEPA, issue renewal of KMC's federal Title V operating permit, if needed.
Hopi Tribe Role: Review the EIS and provide technical information. Participate in government-to-government consultations.	Consult on potential impacts to cultural resources.	Consult on potential impacts to cultural resources. Government-to-government consultation on Section 7 of the ESA and Special Status Species. Consult by performing a technical review of the Life-of-Mine application. Approve or disapprove Clean Water Act Section 401 water quality certifications, if needed.
Gila River Indian Community Role: Act as cooperating agency per Memorandum of Understanding between Reclamation and Gila River Indian Community.	None	None
Pueblo of Zuni Role: Review the EIS and provide technical information. Participate in government-to-government consultations.	Consult on potential impacts to cultural resources.	Consult on potential impacts to cultural resources. Government-to-government consultation on Section 7 of the ESA and Special Status Species.

Table ES-1 Preliminary List of Federal Actions for the NGS-KMC Project

Entity and Role in EIS	Approval Action – NGS and Associated Facilities, WTS, and STS	Approval Action – Proposed KMC
Central Arizona Water Conservation District Role: Act as cooperating agency per Memorandum of Understanding between Reclamation and the Central Arizona Water Conservation District.	None	None
Arizona Game and Fish Department Role: Act as cooperating agency per Memorandum of Understanding between Reclamation and the Arizona Game and Fish Department.	None	None

ES1.4 Development and Description of Alternatives

Public comments received during the scoping period expressed strong support for Reclamation reducing its share of carbon emissions associated with supplying power to the CAP. Numerous commenters supported the study of potential EIS alternatives focused on replacing all or a portion of the federal share of NGS power with power from sources that would reduce atmospheric emissions over those of the Proposed Action. A majority of scoping comments related to alternatives to the Proposed Action advocated the use of renewable energy sources.

ES1.4.1 Alternatives Considered but Eliminated from Detailed Analysis in the EIS

Alternatives were eliminated from further consideration if they could not provide a continuously available and reliable source of power and energy to operate the CAP pumps, which would be competitively priced with NGS and could be sold as surplus power to generate revenues for deposit to the Development Fund.

The purpose and need for the Proposed Action focuses only on the federal share of power and energy from NGS; however, to ensure full consideration of all reasonable alternatives that could meet the purpose and need for the Proposed Action, Reclamation investigated the practicability of replacing NGS in its entirety, with power generation facilities that would emit less carbon than coal (i.e., lower emitting sources). Potential generation alternatives included retrofitting NGS to natural gas; hydropower; nuclear power; distributed power generation along the CAP system; biomass; and conservation. These potential alternatives were rejected because they would not meet the purpose and need for the Proposed Action due to infeasibility (retrofitting NGS to natural gas, distributed power generation along the CAP system, biomass, conservation) or unavailability (hydropower, nuclear). No alternatives that replaced NGS in its entirety were carried forward.

Reclamation also explored replacing major elements associated with the existing NGS and proposed KMC, which could reduce the overall environmental impacts of the Proposed Action. The lack of any technical or environmental advantage associated with replacing these components and associated economic costs and/or environmental impacts resulted in no reasonable alternatives being carried forward that replaced existing major project elements.

Reclamation then considered alternatives that could replace the entire federal share of NGS (547 MW) and be sold as surplus power. To assist in this evaluation, the National Renewable Energy Laboratory, a part of the Department of Energy, conducted an analysis of wholesale electricity prices. This analysis encompassed historical pricing trends, time-of-day variations, and pricing patterns in the energy futures market (National Renewable Energy Laboratory 2015). Reclamation concluded the most cost effective total federal replacement alternative, a combined-cycle natural gas plant, could result in power generation costs that would be higher than the reasonably foreseeable market price of power; therefore, this alternative likely would not be able to generate surplus power revenues. Because total federal replacement of NGS would not be able to generate surplus power revenues for deposit to the Development Fund, this alternative was not carried forward.

ES1.4.2 Alternatives Evaluated in the EIS

Reclamation concluded that only a partial federal replacement (PFR) alternative, which would include continued operation of the NGS to provide a portion of the power needed to operate the CAP system and enable surplus power revenues to be generated, would fulfill the purpose of and need for the Proposed Action. Through the public scoping process, three central themes with respect to alternatives development became evident: 1) seek to minimize energy costs to the CAP; 2) explore renewable energy technology as an economically viable option; and 3) consider tribal socioeconomic impacts. Development of the three PFR alternatives evaluated in the EIS attempted to address these three themes.

ES1.4.2.1 NGS-KMC Project (Proposed Action)

Under the Proposed Action, NGS would be authorized to continue operating from December 23, 2019, through December 22, 2044 (2020-2044), plus decommissioning. Historical (through 2019) NGS-related operation, maintenance, and repair/replacement practices would be expected to continue during this additional 25-year operational period. NGS would continue to supply the federal share of NGS power and energy (approximately 547 MW) that would be used to operate the CAP pumps and be sold as surplus energy to generate funds for deposit to the Development Fund. Adjustments would be made as appropriate to comply with changing environmental regulations, as well as new applicable regulations that become effective during the 2020-2044 timeframe.

The most significant of these new regulations is the Federal Implementation Plan related to the Clean Air Act Regional Haze Rule, which was promulgated August 8, 2014, by the USEPA. Implementation of these regulations at NGS depends upon final NGS ownership arrangements. The timing and manner of implementation of the Federal Implementation Plan would be affected by how NV Energy exits from NGS generation ownership and participation, and whether or not it sells its shares to a third-party. It also is unclear if and when the Navajo Nation would exercise its option to become a Co-tenant of NGS with an entitlement of up to 170 MW under Lease Amendment No. 1 (or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1). As a result of these currently unknown ownership arrangements, there are a number of operating scenarios that could occur under the Proposed Action. The main difference among them is whether the plant would be operated with 3 or 2 units to meet owner generation entitlements. This decision is not a choice to be made by the Secretary; rather, it will be dictated by generation requirements of the final ownership arrangements.

For purposes of the EIS, emissions from the Proposed Action were calculated for a range of operations that could be implemented based on both 3-Unit Operation and 2-Unit Operation. The 3-Unit Operation would continue historical operations; however, in 2026-2027, selective catalytic reduction would be installed on all three units. Under the 2-Unit Operation, one of the 750-MW units would be decommissioned at the end of 2019. The remaining two units would continue to operate and in 2029-

2030, selective catalytic reduction would be installed. The operating units with selective catalytic reduction installed would then continue to operate until 2044, when the plant would be decommissioned and shut down. Either operation would result in compliance with the Federal Implementation Plan by the end of the 25-year period. The NGS and its associated facilities would be decommissioned consistent with the terms of the 1969 Lease and Lease Amendment No. 1 (or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1).

Coal mining operations under the Proposed Action would mirror the NGS operations ultimately implemented. Under the 3-Unit Operation, mining operations and the amount of coal mined and delivered to NGS would continue at a rate of approximately 8.1 million tons per year. Under the 2-Unit Operation, the amount of coal mined and delivered to NGS would be approximately 5.5 million tons per year; all other mining operations would remain essentially the same as under the 3-Unit Operation, including the amount of water pumped from the Navajo Aquifer (N-Aquifer). Final land reclamation would begin in 2044 and be completed within 10 to 15 years.

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

As part of the Proposed Action, conservation measures that are agreed upon with the U.S. Fish and Wildlife Service would be implemented to ensure that impacts from the continued operations of NGS and the proposed KMC would not jeopardize the continued existence of federally listed species or adversely modify designated critical habitat.

ES1.4.2.2 Natural Gas Partial Federal Replacement Alternative

Under this alternative, a portion of the federal share of NGS power and energy would be replaced by natural gas, assumed to be generated by an existing combined cycle plant and purchased through a Power Purchase Agreement. For purposes of this EIS, it was assumed that between 100 MW and 250 MW would be replaced. The natural gas replacement power would be supplied on a 24-hour, 7 days a week basis. NGS would curtail its output by the corresponding amount and would continue production to generate the Co-tenants' entitlements and the remaining amount of the federal share, including power that is surplus to CAP operational needs. This surplus power would be sold at market rates to produce revenue for deposit to the Development Fund. This alternative analysis assumes utilization of existing natural gas resources to reduce net emissions and minimize resulting cost increases, while maintaining the availability and value of surplus energy from NGS at approximately the same quantities as under the Proposed Action.

ES1.4.2.3 Renewable Partial Federal Replacement Alternative

Under this alternative, a portion of the federal share of NGS power and energy would be replaced by power generated by renewable resources that would be purchased through a Power Purchase Agreement. It was assumed that between 100 MW and 250 MW would be replaced. The renewable energy would be supplied to the CAP during a defined time period. For purposes of this EIS, it was assumed that this would be 14 hours per day, 7 days a week. The Power Purchase Agreement would require that a non-renewable source of power be included for the 14-hour period to maintain reliability during short-term fluctuations in output (e.g., cloud cover). NGS would curtail its output by the corresponding amount and would continue production to generate the Co-tenants' entitlements and the remaining amount of the federal share, including surplus power that is sold at market rates to produce revenue for deposit to the Development Fund. This alternative analysis assumes utilization of existing renewable energy resources to reduce net emissions, while maintaining the availability and value of surplus energy from NGS at approximately the same quantities as under the Proposed Action.

ES1.4.2.4 Tribal Partial Federal Replacement Alternative

Under this alternative, a portion of the federal share of NGS power and energy would be replaced by power purchased through a Power Purchase Agreement. That power would be generated by a new renewable energy facility constructed on NGS-affected tribal land. For purposes of this EIS, it was assumed that this would be a photovoltaic solar facility, and that energy from this facility would be dedicated to meet a portion of CAP demands (between 100 MW to 250 MW) during daylight hours (12 hours per day, 7 days a week), ramping up during the morning hours, leveling out during the middle of the day, and then ramping down during the evening. Similar to the Renewable PFR, the Tribal PFR would require that a non-renewable source of power be included for the defined period of delivery to maintain reliability during short-term fluctuations in output (e.g., cloud cover). NGS would curtail its output by the corresponding amount and would continue production to generate the Co-tenants' entitlements and the remaining amount of the federal share, including surplus power that is sold to produce revenue for the Development Fund. This alternative would reduce net emissions using renewable technology and provide an opportunity for NGS-affected tribes to develop photovoltaic solar capacity, while maintaining the availability and value of surplus energy from NGS at approximately the same quantities as under the Proposed Action. Federal action(s) associated with development of a photovoltaic solar facility on tribal land would necessitate compliance with the NEPA, ESA, and National Historic Preservation Act, as appropriate, before a Power Purchase Agreement would be authorized. If use of a ROW or intertie to a transmission line or substation is needed, required federal approval and additional compliance with federal environmental statutes (e.g., NEPA, ESA, and National Historic Preservation Act) would be obtained for construction of transmission-related infrastructure as a subsequent action.

ES1.4.2.5 No Action Alternative

Under the No Action Alternative, the 1969 Lease, associated ROWs, and other arrangements would not be extended past December 22, 2019. NGS decommissioning activities would be completed by the end of 2019. Reclamation of the coal mine and mining operations would begin in 2019 and would continue for 10 to 15 years until final bond release.

The NGS Co-tenants would need to obtain sufficient capacity and baseload energy to replace the amount lost due to the closure of NGS. Each Co-tenant would work independently to develop and secure its replacement resources. Current supply and demand projections for the region suggest that the predominant source of long-term replacement of baseload resources eventually would be the construction of new gas-fired, combined-cycle generation located at low elevations and near existing gas supply lines, transmission lines, water supplies, and the load areas of the Co-tenants. It is not possible to accurately predict the location, number, or size of the replacement generating resources because of the many variables that each utility would consider in its resource replacement strategy, including compliance and cost of environmental regulations such as the forthcoming ozone standards. A combined cycle gas-fired generating station typically would require a minimum of 4 years to over 6 years to plan, site, permit, and construct. In the interim, each utility would ensure sufficient baseload power resources for their customers through: (1) use of their existing generating resources, if available; (2) the acquisition of existing merchant generation capacity; (3) Power Purchase Agreements; or (4) some combination of such resources. The ability to defer the construction of new replacement resources by utilizing existing resources would be dependent on regional peak capacity and demand conditions. It may be the case that limited excess peak capacity would exist and the construction of new resources would be expedited to ensure grid reliability.

The NGS transmission system is an established part of the western U.S. transmission grid and supports reliability and delivery of power throughout the region, well beyond the power generated by the NGS. Therefore, under the No Action Alternative, one, several, or all of the land owners/managers of the transmission line ROWs and communication site leases likely would renew some portion of the facilities to keep the power grid performing as expected.

In the event that some or all of the transmission systems and communication site ROWs are not renewed, a lengthy study, permitting process, and construction of replacement facilities would need to occur before decommissioning is initiated due to the essential and integral nature of these facilities with the western U.S. transmission grid. An estimated 4,826 acres within and alongside the transmission system corridors could be temporarily disturbed if the entirety of the transmission systems and communication sites were decommissioned and removed.

Under the No Action Alternative, NGS power and energy no longer would be available to operate the CAP pumps. As system operator, the Central Arizona Water Conservation District (CAWCD) would continue to be responsible for obtaining the power necessary to deliver CAP water. CAWCD has indicated that it would develop a diversified energy portfolio to manage risk and moderate impacts from energy market volatility, if and when NGS is no longer available. CAWCD has further indicated its goal would be that no individual generation source or contractual supply would make up more than 15 to 20 percent of that portfolio (CAWCD 2013). Under this alternative, CAWCD would acquire just enough power to meet CAP pump loads. There would be no surplus power or energy that could be sold to create revenues for CAP repayment assistance or to benefit other purposes of the Development Fund.

Approximately 2.9 million MW hours of electricity is needed annually to meet CAP pumping requirements. That equates to an average hourly power requirement of approximately 350 MW, which CAWCD would meet through baseload resources. For purposes of this EIS, it was assumed that CAWCD would look to natural gas-fueled generation to meet its baseload power needs. Natural gas commonly is used as a peaking resource and could provide baseload generation for CAP. According to information supplied by USEPA in connection with its Clean Power Plan, the current capacity factor of natural gas located in Arizona is 27 percent. However, it appears that existing natural gas capacity is fully utilized in the summer months to meet Arizona’s peak demands. It also is not clear how the closure of NGS would affect surplus natural gas capacity after 2019. Therefore, while there may be unused natural gas capacity that could supply a portion of CAP’s needs, CAWCD may need to construct its own natural gas facility to obtain a baseload resource for summer months.

CAWCD may be able to use renewable resources (most likely solar) to supply a minor portion of its energy portfolio, but such resources cannot meet CAP’s baseload need. Independent of the generation sources CAWCD chooses to replace NGS, it likely would be necessary to construct new transmission lines to deliver that energy to CAP pumps. There is little or no available transmission capacity that could convey energy to CAP pumps from the Palo Verde hub, which is the most likely delivery location for purchased power in Arizona. The amount, intensity, and duration of ground disturbance and construction-related noise and traffic from construction of a renewable energy facility would be dependent upon the type of facility being constructed.

ES1.5 Primary Technical Issues

The development of this EIS was shaped by several key technical issues that were defined during public scoping. The following is a summary of the key issues, and the technical studies that were performed to address these issues, where applicable. Available project-related materials are available for viewing or download at http://NGSKMC-EIS.net.

- Air Quality. Issues include local- and regional-scale air quality, including regional haze, ozone, and criteria air pollutants that would require modifications to NGS operations to comply with the USEPA Regional Haze Rule. Air quality modelling was conducted that characterized criteria and hazardous air pollutant concentrations; NGS stack plume visibility within 50 kilometers (km) of NGS; estimated NGS contributions to regional haze, ozone concentrations, and acid deposition in Class 1 air quality areas; and characterized criteria pollutant concentrations from operations at the proposed KMC.
- Climate Change. Issues include coal combustion contributions to regional and global greenhouse gas concentrations. Project (i.e., from NGS, proposed KMC, ancillary sources)

greenhouse gas emissions were estimated for the proposed operating period. Social costs of carbon were estimated from greenhouse gas emissions in accordance with federal agency methods.

- Water Resources on Black Mesa. Issues include past and continued mining-related withdrawals of N-Aquifer groundwater in relation to spring flows and groundwater contributions to surface water flows in major drainages. Groundwater modeling of the N-Aquifer was conducted to account for the aquifer drawdown and surface flow impacts of past, present, and future pumping from mining wells as well as withdrawals from community water supply wells.
- Ecological Risks from Trace Metal Deposition. Issues include ecosystem health effects of certain trace metals (mercury, arsenic, selenium) emitted from NGS stacks. The primary impact focus was on aquatic ecosystems in the Colorado River system, particularly threatened and endangered fish listed by the U.S. Fish and Wildlife Service. Soil, water, and sediment sampling were conducted in the vicinity of NGS and the proposed KMC to establish a current baseline. The results of this sampling were used as inputs to ecological risk assessments that were conducted in accordance with USEPA protocols. The endpoints of these assessments were predicted metal concentrations in plant, animal, and fish tissue, as well as potential toxicity.
- Public Health Risk from Trace Metal Deposition, Exposure to Fugitive Dust. Issues include human health impacts from accumulation of trace metals through the food chain and direct exposure from dust inhalation. The primary focus was on communities surrounding NGS (i.e., Page and LeChee) and residents living in the vicinity of the proposed KMC. The baseline soils, water, and air quality sampling data were used to conduct public health risk assessments for both NGS and the proposed KMC in accordance with USEPA protocols. The endpoints of these assessments were cancer and non-cancer risks. Other factors that contribute to community health, such as the availability of health care, also were evaluated.
- Cultural Resources on Black Mesa. Issues include discovery and treatment of cultural resources, including burials that would be removed prior to disturbance or avoided during surface coal mining and other project activities, and broader concerns about effects on special places of religious or cultural significance (Traditional Cultural Properties) from continued surface coal mining. Past cultural resource surveys on Black Mesa and along the transmission system ROWs were compiled into reports, and additional ground surveys were conducted in 2015 and 2016 within the proposed KMC coal resource areas and within the WTS corridor. Separate programmatic agreements, which provide guidance on the treatment of newly discovered cultural resources, were developed for NGS and the proposed KMC project components. These programmatic agreements were reviewed for approval by affected federal agencies, tribes, and states. Ethnographic studies conducted for the Navajo Nation, Hopi Tribe, and Pueblo of Zuni involve interviews with tribal elders, and traditional medicine practitioners to identify Traditional Cultural Properties and provide a perspective on the world views of tribal communities.
- Socioeconomic Impacts of NGS and Proposed KMC Operational Changes. Issues include potential reduced future employment at NGS and the proposed KMC and the economic and social consequences to worker families, communities, and tribal governments and increased pumping costs for CAP water as the result of operational changes at NGS. Assumptions regarding future employment and payments to tribes were made based on changes in volumes of coal burned at NGS and mined at the proposed KMC, which were then extrapolated in terms of changes in payrolls, government revenues, and public services in affected communities.

ES1.6 Affected Environment and Environmental Consequences

ES1.6.1 Affected Environment

The following paragraphs provide a brief summary of the study areas and the resource conditions that are described in the Affected Environment sections of the EIS. Where applicable, information from the ecological and human health risk assessments has been included to characterize baseline conditions in 2019.

Air Quality. Air quality was addressed at two geographic scales. The smaller study areas included a radius of 50 km around the NGS and the proposed KMC to document the measured concentrations of criteria and hazardous air pollutants that occur near these sources. The larger study area extended 300 km from NGS to address the airborne pollutant concentrations that contribute to visibility impairment, regional haze, and acid deposition. Study area pollutant concentrations are in compliance with national standards except for ozone in urban areas.

Climate and Climate Change. Greenhouse gas emissions from NGS and other project activities were addressed within the same study areas as air quality. Trends in greenhouse gas emissions at national and global scales show a long-term increase in global carbon dioxide concentrations, the primary indicator of global warming. Regional trends in natural resource responses to climatic factors include long-term reductions in annual streamflows within the Colorado River watershed, plant and animal distribution changes over time resulting from seasonal temperature changes, and observations by tribal communities that the availability of water for drinking, stock watering, and agriculture has become more variable.

Geology and Landforms. No unique geologic features or landforms underlying or near project components were identified. Earthquake and fault movement risks are very low based on the historical record.

Mineral Resources. Bituminous coal is the primary commercial mineral resource, and no interference with existing mining operations is occurring from other surface activities.

Paleontological Resources. The surficial geologic formations underlying the project components are considered to be of low scientific value.

Soil Resources. Soils underlying project components are characteristic of desert and semi-arid regions and generally are shallow with limited soil horizon development and organic matter. Soils are salvaged and stockpiled or replaced directly over final graded overburden at the proposed KMC to provide a suitable 4-foot thick revegetation medium. Trace metal concentrations in soils within 20 km of NGS generally are similar to regional background concentrations and do not exceed USEPA screening levels used to identify ecological and public health risks.

Water Resources. The water supply for NGS is Lake Powell, a large Colorado River reservoir that provides all water necessary for NGS operations at a quality suitable for industrial uses. The primary groundwater study area is the extent of the N-Aquifer, a regional aquifer that underlies Black Mesa. The N-Aquifer provides dust control and potable water for the proposed KMC as well as potable water for residents near the proposed KMC, including Navajo and Hopi communities. A variety of springs discharge from the N-Aquifer where the water-bearing zone contacts the land surface at distances of 5 to 10 miles from the proposed KMC. Flows in large washes that drain the upper elevations of Black Mesa are intermittent to ephemeral and are subject to periodic high flows from storm events. Surface water quality in Black Mesa wash channels is variable and generally suitable for livestock use.

Vegetation Resources. Vegetation communities within the study area are typical of desert and semi-arid regions, dominated by desert shrublands, sagebrush shrublands, and pinyon pine- juniper woodlands at higher elevations. Soil concentrations of trace metals within 20 km of NGS and at greater distances are not elevated and do not cause toxicity to native vegetation, based on the ecological risk assessments. Similarly, no toxicity risks to vegetation were identified from the proposed KMC under baseline conditions.

Special Status Vegetation Resources. No special status plants are known to occur within the existing and proposed activity areas for NGS and the proposed KMC. Seven special status plants (U.S. Fish and Wildlife Species and Navajo listed species) are known or potentially occur within 20 km of the NGS, no special status plants occur or potentially occur within the proposed KMC, and three special status plants occur or potentially occur in the N-Aquifer study area. Thirty-two species of special status plants are known or potentially occur within the WTS and STS ROWs. Baseline soil concentrations of trace metals within 20 km of NGS and at greater distances are not elevated and do not cause toxicity to special status plant species, based on the ecological risk assessments. Similarly, no toxicity risks to vegetation were identified from the proposed KMC under baseline conditions.

Terrestrial Wildlife Resources. Terrestrial wildlife habitats include the shrublands and woodlands described for vegetation. Riparian and open water habitats (except for Lake Powell) occupy very little of the study area and primarily are located with perennial drainages crossed by the WTS and STS (e.g., Agua Fria River, Virgin River) and intermittent drainages on Black Mesa. Primary terrestrial animal groups include big game, medium-sized and small mammals, and reptiles. Study areas where wildlife ecological risk assessments were conducted included the vicinity of NGS (Near-field); vicinity of proposed KMC; Colorado River upstream and downstream of Lake Powell (Gap Regions); and the San Juan River drainage from Lake Powell upstream to northwestern New Mexico. Based on ecological risk assessments of primary exposure pathways (i.e., air, soil, vegetation, and water), negligible trace metal impacts are present for all wildlife groups within all study areas under baseline conditions.

Terrestrial Wildlife Special Status Species. Based on habitat requirements, known and potential occurrence, and potential interaction with project components, the following federal species were selected for detailed assessment in the EIS: California condor, Mexican spotted owl, southwestern willow flycatcher, western yellow-billed cuckoo, Mojave Desert tortoise, Sonoran Desert tortoise, narrow-headed gartersnake, and northern Mexican gartersnake. Ten additional federal and tribal special status species occur or potentially occur within the NGS study area, six species occur or potentially occur within the proposed KMC and N-Aquifer study areas, and 50 species occur or potentially occur within the WTS and STS study areas. Negligible ecological risks from trace metals from assessment of primary exposure pathways (i.e., air, soil, vegetation, and water) are present for all special status wildlife groups within all study areas under baseline conditions (see Terrestrial Wildlife Resources above).

Aquatic Biological Resources. Primary aquatic habitats within the overall study area include Lake Powell, the Colorado and San Juan River upstream of Lake Powell, and the Colorado River downstream of Lake Powell to Lake Mead. Fish in these river and reservoir habitats mostly are non-native species. Striped bass in Lake Powell and rainbow trout in the Colorado River below Glen Canyon are important recreational species. Based on measured water quality and fish tissue concentrations, potential risks to fish populations in the Colorado River below Lake Powell are present from exposure to mercury and selenium and to fish populations in the San Juan River from exposure to selenium. Negligible risks to aquatic communities in ponds and drainages on the proposed KMC are present under baseline conditions.

Special Status Aquatic Species. Based on habitat requirements, known and potential occurrence, and potential interaction with project components, the following federal aquatic species were selected for detailed assessment in the EIS: bonytail, Colorado pikeminnow, humpback chub, razorback sucker, Kanab ambersnail, desert pupfish, gila chub, gila topminnow, loach minnow, roundtail chub, spikedace, Virgin River chub, and woundfin. An additional 11 species of fish and amphibians are known or potentially occur within the WTS and STS transmission line study areas. Based on measured water quality and fish tissue concentrations, potential risks are present under baseline conditions to Colorado pikeminnow populations in the San Juan River from exposure to mercury, to razorback sucker populations in the Colorado River below Lake Powell from exposure to mercury, and to razorback sucker populations in the San Juan River from exposure to mercury and selenium.

Land Use. NGS and portions of the proposed KMC, WTS, and STS are located on Navajo Nation lands. Other ownerships include the National Park Service (for the water pipeline from Lake Powell to NGS), Hopi Tribe for southern portions of the proposed KMC, and BLM and U.S. Forest Service for portions of the WTS and STS. A variety of BLM special designation areas are crossed by the transmission lines. The primary land use is for livestock grazing while wildlife habitat and cultural plants are important at the proposed KMC. The entire region is sparsely populated. The communities of Page and LeChee are located within 5 miles of NGS; small (approximately 150 people) dispersed residential clusters are located within or near the proposed KMC. Lands disturbed by mining activity are progressively revegetated. Revegetated lands at the proposed KMC are returned to the Navajo Nation or Hopi Tribe, subject to release of a performance bond administered by the OSMRE and BIA approvals.

Public Safety. The NGS plant site is not accessible to the public. The primary NGS ground-level activities that may affect the public and public resources include coal delivery by railroad, truck delivery of products and industrial chemicals, and coal ash disposal, which includes sales of fly ash. Fly ash is removed from the plant site by truck. Warning signs are provided for at-grade road crossings of the Black Mesa and Lake Powell (BM&LP) Railroad. The active mine area at the proposed KMC is not accessible to the public, but a public road (Navajo Route 41) traverses 2 to 3 miles west of active mining areas, and individual residences are scattered throughout the proposed KMC area. Residents are relocated away from active mining pits to minimize exposure from periodic overburden blasting events and noise from mining activities. No residential structures are located within the WTS and STS ROWs, limiting long-term human exposure to potential electromagnetic radiation from transmission line conductors.

Public Health and Human Health Risk. The study areas for the human health risk assessments included the vicinity of NGS (out to 20 km from the source) and the area within the proposed KMC. The focus of the risk assessments was human exposure to trace metals via various pathways (i.e., air, soil, water, and food consumption). Based on human health risk assessments, baseline conditions for cancer risks for populations near NGS are within the USEPA-acceptable range, except for child recreational users who may be exposed to methyl mercury from consuming fish caught from Lake Powell. Blood lead concentrations are well below USEPA target blood levels under baseline conditions. Cancer and non-cancer risks for residents within the proposed KMC are within the USEPA acceptable range, and the proposed KMC resident lead concentrations are well below USEPA target blood levels, under baseline conditions.

The human population and public health services considered for the community health assessment included the inhabitants of the Navajo Nation and Hopi Tribe within the study areas defined for human health risk. The focus of this assessment was on contaminant exposure and stress factors, economic factors, and institutional factors contributing to community health. The primary contaminant factors (fugitive dust) are addressed in the human health risk assessment. The proposed KMC residential exposure to noise and blasting, potential for residential relocation as mining advances, changes in access to livestock grazing areas, and concerns about cultural resources removal potentially are important stress factors. Beneficial economic factors include employment, increased income, and access to health care; the inverse of these factors include unemployment without other employment options and inadequate income to purchase services, including health care. Health surveys indicate that the Navajo County population is among the least healthy in Arizona. Key negative health indicators include high incident rates for obesity, smoking, alcohol use, diabetes, cancer, cardiovascular disease, respiratory disease, and accidents. Outside air quality conditions at ground level are within air quality standards (see Air Quality).

Cultural Resources. Study areas for cultural resources include all the surface area already committed to project components, plus the proposed KMC coal resource areas that would be mined between 2020 and 2044. Additional ground surveys for cultural resources have been, or would be completed in areas where there are data gaps (WTS) and areas proposed for coal mining during the 2020-2044 period. Ethnographic/Traditional Cultural Properties studies are being completed for the Navajo Nation, Hopi Tribe, and Pueblo of Zuni. This region has been occupied by Native Americans over a period of nearly

10,000 years, and many examples of hunter/gatherer sites, as well as settlements supported by agriculture, have been discovered and described. Four archeological sites have been identified within the NGS plant site, 60 sites within the BM&LP Railroad ROW, and approximately 2,760 sites within the proposed KMC, which includes the former Black Mesa Mine and existing Kayenta Mine. Seventy-two places of religious and cultural significance to local individuals and families within the proposed KMC have been identified to date. A range of 200 to 224 archaeological sites currently are known from areas proposed to be mined from 2020 to 2044, numbers that may increase as a result of additional surveys. Twenty-four Traditional Cultural Properties, including places with known or expected burials, have been identified in areas proposed for new mining. One hundred twenty-nine (129) archaeological sites have been identified within the WTS corridor; additional sites are anticipated to be identified based on the new survey. Three hundred twenty archaeological sites are associated with the STS, which has been completely surveyed. Nine archaeological sites have been identified from surveys on 15 communications sites; 5 communications sites are considered possible Traditional Cultural Properties because they are located on regional highpoints.

Socioeconomics. The local socioeconomic study area encompasses the Navajo Nation chapters that surround NGS and the proposed KMC and the entire Hopi Reservation. A regional study area includes the communities and infrastructure within Coconino, Navajo, and Apache counties in Arizona, as well as the Navajo Nation in western New Mexico. Also included in a regional study area are lands of ten southern Arizona tribes with CAP water allocations.

Navajo Nation tribal enrollment is more than 300,000 people; Hopi tribal enrollment is approximately 14,000 people. Tribal member unemployment is high, and income is low compared to Arizona as a whole. Primary employment sources are the public sector, agriculture, mining, utilities, and tourism. In 2014, NGS employed 495 workers, of which 86 percent were Native American. The Kayenta Mine employed 440 workers, of which 96 percent were Native American. NGS Participant payments to the Navajo Nation and property taxes exceed $50 million annually. Royalties, taxes, and other fees paid by PWCC to tribal and local governments total more than $57 million annually. PWCC provides potable water, road maintenance, emergency response capability, heating coal, and infrastructure services and maintenance as benefits to the nearby communities.

The 10 tribes with CAP water allocations occupy reservations with a land area in excess of 6.7 million acres, and receive annual allocations of almost 576,000 acre-feet of Colorado River water per year. Household incomes of tribal members generally are below state and national averages, and poverty rates generally are above county averages. The CAWCD purchases 90 percent of its electrical energy from NGS. In 2014, net water delivery charges were $188 million. The 2014 pumping energy costs equate to $67 per acre foot.

Environmental Justice. The study areas for environmental justice are the same as those described for socioeconomics. The populations living in these study areas meet the environmental justice guidelines for minority and low-income residents.

Indian Trust Assets. Indian trust assets are legal interests in property held in trust by the U.S. for Indian tribes or individuals. Trust assets may include lands, minerals, hunting and fishing rights, and water rights. Indian trust assets addressed in this EIS include:

- NGS – water and land trust assets;
- Proposed KMC – water, land, mineral, and hunting trust assets;
- Transmission lines and communication sites – land trust assets; and
- CAP – water trust assets.

ES1.6.2 Environmental Consequences

Table ES-2 provides a summary of the NGS and KMC land and water requirements for the alternatives, power generation assumptions, key air pollutant emissions, and employment, labor income, and lease and other payments. This table provides an overview of impact sources that contribute to the impact summary presented in **Table ES-3**.

Table ES-3 displays a summary of the impacts of all the alternatives on the various resources discussed in the EIS. The No Action Alternative provides a baseline against which the impacts of the action alternatives are compared. Due to the nature and extent of the assumptions made when conducting the technical studies used to compare the impacts resulting from each alternative, the analyses provide more value as a comparison across alternatives, rather than as a prediction of actual changes that would occur for a particular resource area.

ES1.7 References

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Table ES-2 Navajo Generating Station – Kayenta Mine Complex Project Quantitative Impact Summary

Resource Requirement / Operational Factor	Proposed Action		Natural Gas PFR Alternative (100-MW and 250-MW reduction)		Renewable PFR Alternative (100-MW and 250-MW reduction)		Tribal PFR Alternative (100-MW and 250-MW reduction)	
	3–Unit	2–Unit	3–Unit	2–Unit	3–Unit	2–Unit	3–Unit	2–Unit
Navajo Generating Station / BM&LP Railroad / Western and Southern Transmission Systems								
Land Requirements (Maximum)								
NGS Plant Site (acres)	2,104	2,064	2,104	2,064	2,104	2,064	2,104 +3,000 for new solar site	2,064 +1,200 for new solar site
BM&LP Railroad ROW (acres)	1,620	1,620	1,620	1,620	1,620	1,620	1,620	1,620
WTS, STS, Substations, Communication Sites; ROW and roads (acres)	27,315	27,315	27,315	27,315	27,315	27,315	27,315 + new tie-line ROW	27,315 + new tie-line ROW
Natural Resource Requirements								
Water from Lake Powell for NGS (acre-feet/year)	29,000	19,340	-100 MW: 27,840 -250 MW: 25,230	-100 MW: 17,986 -250 MW: 16,052	-100 MW: 28,103 -250 MW: 27,260	-100 MW: 18,566 -250 MW: 17,406	-100 MW: 28,420 -250 MW: 27,550	-100 MW: 18,670 -250 MW: 17,986
Coal delivered from Kayenta Mine (million tpy)	8.1	5.5	-100 MW: 7.7 -250 MW: 7.1	-100 MW: 5.1 -250 MW: 4.5	-100 MW: 7.9 -250 MW: 7.5	-100 MW: 5.3 -250 MW: 4.9	-100 MW: 7.9 -250 MW: 7.7	-100 MW: 5.3 -250 MW: 5.1
Power and Energy Generation								
Design power capacity; NGS at 88% capacity (MW)	1,980	1,320	-100 MW: 1,880 -250 MW: 1,730	-100 MW: 1,220 -250 MW: 1,070	-100 MW: 1,922 -250 MW: 1,834	-100 MW: 1,268 -250 MW: 1,174	-100 MW: 1,939 -250 MW: 1,877	-100 MW: 1,279 -250 MW: 1,217
Federal energy from NGS (terawatt hours/year)	4.17	4.12	-100 MW: 3.29 -250 MW: 1.98	-100 MW: 3.24 -250 MW: 1.93	-100 MW: 3.66 -250 MW: 2.89	-100 MW: 3.61 -250 MW: 2.84	-100 MW: 3.83 -250 MW: 3.33	-100 MW: 3.78 -250 MW: 3.28
Federal energy from NGS supplied to CAP (terawatt hours/year)	2.70	2.70	-100 MW: 1.82 -250 MW: 0.51	-100 MW: 1.82 -250 MW: 0.51	-100 MW: 2.19 -250 MW: 1.42	-100 MW: 2.19 -250 MW: 1.42	-100 MW: 2.36 -250 MW: 1.86	-100 MW: 2.36 -250 MW: 1.86
Alternative energy source to CAP (terawatt hours/year)	--	–	-100 MW: 0.88 -250 MW: 2.19	-100 MW: 0.88 -250 MW: 2.19	-100 MW: 0.51 -250 MW: 1.28	-100 MW: 0.51 -250 MW: 1.28	-100 MW: 0.33 -250 MW: 0.83	-100 MW: 0.33 -250 MW: 0.83
NGS energy available as surplus (terawatt hours/year)	1.47	1.42	1.47	1.42	1.47	1.42	1.47	1.42

Table ES-2 Navajo Generating Station – Kayenta Mine Complex Project Quantitative Impact Summary

Resource Requirement / Operational Factor	Proposed Action		Natural Gas PFR Alternative (100-MW and 250-MW reduction)		Renewable PFR Alternative (100-MW and 250-MW reduction)		Tribal PFR Alternative (100-MW and 250-MW reduction)	
	3–Unit	2–Unit	3–Unit	2–Unit	3–Unit	2–Unit	3–Unit	2–Unit
Annual energy charges to CAP; maximum cost/year for 2030 to 2044 operations (million dollars)	144.8	152.3	-100 MW: 153.4 -250 MW: 180.1	-100 MW: 168.5 -250 MW: 179.6	-100 MW: 155.0 -250 MW: 167.2	-100 MW: 161.2 -250 MW: 172.0	-100 MW: 151.5 -250 MW: 160.6	-100 MW: 158.5 -250 MW: 165.9
Selected Emissions								
Annual nitrogen dioxide (NO_X) – pre SCR installation (tpy)	20,409	13,606	-100 MW: 19,461 -250 MW: 18,039	-100 MW: 12,658 -250 MW: 11,236	-100 MW: 19,811 -250 MW: 18,914	-100 MW: 13,008 -250 MW: 12,111	-100 MW: 20,019 -250 MW: 19,436	-100 MW: 13,216 -250 MW: 12,633
Annual nitrogen dioxide (NO_X) – post SCR installation (tpy)	6,803	4,535	-100 MW: 6,542 -250 MW: 6,151	-100 MW: 4,274 -250 MW: 3,883	-100 MW: 6,606 -250 MW: 6,310	-100 MW: 4,338 -250 MW: 4,042	-100 MW: 6,674 -250 MW: 6,482	-100 MW: 4,406 -250 MW: 4,214
Greenhouse gases; carbon dioxide equivalent (million tpy)	18.38	12.30	-100 MW: 17.86 -250 MW: 17.07	-100 MW: 11.77 -250 MW: 10.98	-100 MW: 17.86 -250 MW: 17.08	-100 MW: 11.78 -250 MW: 10.99	-100 MW: 18.05 -250 MW: 17.53	-100 MW: 11.96 -250 MW: 11.45
Employment, Income, and Payments								
Regional jobs (direct, indirect, and induced) – typical year (full–time equivalents)	2,164	1,616	-100 MW: 2,077 -250 MW: 1,999	-100 MW: 1,535 -250 MW: 1,453	-100 MW: 2,096 -250 MW: 2,054	-100 MW: 1,559 -250 MW: 1,509	-100 MW: 2,125 -250 MW: 2,113 + 533 or 636 construction jobs, respectively, for 1.5 or 2.5 to 3 yr.	-100 MW: 1,586 -250 MW: 1,568 + 533 or 636 construction jobs, respectively, for 1.5 or 2.5 to 3 yr.
Annual labor income (direct, indirect, induced) – (million dollars)	149.8	110.8	-100 MW: 142.6 -250 MW: 133.5	-100 MW: 105.4 -250 MW: 96.5	-100 MW: 144.3 -250 MW: 139.6	-100 MW: 107.9 -250 MW: 102.6	-100 MW: 146.0 -250 MW: 143.8 + 1.0 or 1.4, respectively, for new photovoltaic	-100 MW: 96.1 -250 MW: 93.8 + 1.0 or 1.4, respectively, for new photovoltaic
Total NGS lease and other payments to the Navajo Nation; 2020 to 2044 (billion dollars)	1.075	0.79	1.075	0.79	1.075	0.79	1.075 + 0.035 to 0.087 for new photovoltaic	0.79 + 0.035 to 0.087 for new photovoltaic

Table ES-2 Navajo Generating Station – Kayenta Mine Complex Project Quantitative Impact Summary

Resource Requirement / Operational Factor	Proposed Action		Natural Gas PFR Alternative (100-MW and 250-MW reduction)		Renewable PFR Alternative (100-MW and 250-MW reduction)		Tribal PFR Alternative (100-MW and 250-MW reduction)	
	3–Unit	2–Unit	3–Unit	2–Unit	3–Unit	2–Unit	3–Unit	2–Unit
Proposed Kayenta Mine Complex (KMC)								
Land Requirements (Maximum)								
Coal resource areas (acres)	31,475	30,986	31,475	30,986	31,475	30,986	31,475	30,986
Resource Requirements								
Coal to be mined; 2020 to 2044 (million tpy)	8.1	5.5	-100MW: 7.7 -250 MW: 7.1	-100 MW: 5.1 -250 MW: 4.5	-100 MW: 7.9 -250 MW: 7.5	-100 MW: 5.3 -250 MW: 4.9	-100 MW: 7.9 -250 MW: 7.7	-100 MW: 5.3 -250 MW: 5.1
Surface disturbance from mining; 2020 to 2044 (acres)	5,230	4,741	-100MW: 4,968 -250MW: 4,602	-100 MW: 4,409 -250 MW: 3,888	-100 MW: 5,072 -250 MW: 4,863	-100 MW: 4,551 -250 MW: 4,267	-100 MW: 5,724 -250 MW: 4,968	-100 MW: 4,599 -250 MW: 4,409
Groundwater use; 202 to 2044 (acre-feet/year)	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Selected Emissions								
Greenhouse gases; carbon dioxide equivalent (tpy)	71,000	54,000	-100 MW: 68,000 -250 MW: 64,000	-100 MW: 51,000 -250 MW: 47,000	-100 MW: 69,000 -250 MW: 67,000	-100 MW: 52,000 -250 MW: 50,000	-100 MW: 70,000 -250 MW: 68,000	-100 MW: 53,000 -250 MW: 51,000
Employment, Income, and Payments								
Employment (full-time equivalents)	1,648	1,129	-100 MW: 1,573 -250 MW: 1,453	-100 MW: 1,052 -250 MW: 939	-100 MW: 1,603 -250 MW: 1,534	-100 MW: 1,084 -250 MW: 1,017	-100 MW: 1,618 -250 MW: 1,566	-100 MW: 1,095 -250 MW: 1,052
Annual labor income; direct, indirect, induced (million dollars)	110.7	75.8	-100 MW: 105.6 -250 MW: 97.6	-100 MW: 70.4 -250 MW: 62.7	-100 MW: 107.8 -250 MW: 103.0	-100 MW: 72.5 -250 MW: 68.1	-100 MW: 108.7 -250 MW: 105.2	-100 MW: 73.3 -250 MW: 70.4
Total PWCC lease, royalty, bonus, and water payments: 2020 to 2044 (billion dollars)	1.19	0.82	-100 MW: 1.14 -250 MW: 1.05	-100 MW: 0.76 -250 MW: 0.68	-100 MW: 1.16 -250 MW: 1.11	-100 MW: 0.79 -250 MW: 0.74	-100 MW: 1.17 -250 MW: 1.14	-100 MW: 0.80 -250 MW: 0.76

Table ES-3 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.1 Air Quality	The project would be in compliance with national ambient air quality standards, and maximum impacts from both facilities primarily would occur near the sources and decrease with distance. Overall project air quality impacts from 2020 to 2044 (including regional haze and ozone) would be minor to moderate near NGS and the proposed KMC. Source emissions would be reduced by various controls, ranging from stack scrubbers at NGS to watering of haul roads for dust control at the proposed KMC. Deposition of selenium from the proposed KMC would be minor; all other deposition would be negligible. Short-term moderate increases in fugitive dust and equipment emissions would occur during decommissioning over a 1-year period at NGS and a minimum 10-year period at the proposed KMC starting in 2044. In the event some or all of the transmission systems and communication site ROWs (estimated at 4,826 acres) are not renewed/decommissioned,	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Project compliance with air quality standards would be the same as the Proposed Action. Overall project air quality impacts from 2020 to 2044 (including regional haze and ozone) would be minor to moderate near NGS and the proposed KMC. Stack emissions from NGS would be 5 to 19 percent less, and proposed KMC surface disturbance would be 5 to18 percent less than the Proposed Action. Short-term minor increases in fugitive dust and equipment emissions would occur as described for the Proposed Action decommissioning. WTS and STS operations would continue as described for the Proposed Action. Cumulative impacts would be slightly less than for the Proposed Action, and dominated by non-project activities.	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Project compliance with air quality standards would be the same as the Proposed Action. Overall project air quality impacts from 2020 to 2044 (including regional haze and ozone) would be minor to moderate near NGS and the proposed KMC. Stack emissions from NGS would be 3 to 11 percent less, and proposed KMC surface disturbance would be 3 to10 percent less than the Proposed Action. Short-term minor increases in fugitive dust and equipment emissions would occur as described for the Proposed Action decommissioning. WTS and STS operations would continue as described for the Proposed Action. Cumulative impacts would be slightly less than for the Proposed Action and dominated by non-project activities.	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Air quality impacts would be analyzed in a subsequent NEPA action. Project compliance with air quality standards would be the same as the Proposed Action. Overall project air quality impacts from 2020 to 2044 (including regional haze and ozone) would be minor to moderate near NGS and the proposed KMC. Stack emissions from NGS would be 2 to 8 percent less, and proposed KMC surface disturbance would be 2 to 7 percent less than the Proposed Action. Short-term minor increases in fugitive dust and equipment emissions would occur as described for the Proposed Action decommissioning. WTS and STS operations would be as described for the Proposed Action.	NGS stack emissions and Kayenta Mine mining activity emissions would cease in 2019. Air pollutant ground level concentrations would return to background levels. Short-term moderate increases in fugitive dust and equipment emissions would occur during decommissioning operations at both NGS (2018-2019) and the Kayenta Mine (over minimum 10-year period starting in 2019). The NGS transmission system is an established part of the western U.S. transmission grid and supports reliability and delivery of power throughout the region, beyond the power from NGS. Under the No Action Alternative, it is likely that that one, several, or all of the land owners/managers of the transmission line ROWs and communication site leases would renew all or part of the facilities to maintain expected power grid performance. In the event some or all of the transmission systems and communication site ROWs (estimated at 4,826 acres total) are not renewed, a lengthy study and permitting process, and

Table ES-3 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.1 Air Quality (continued)	a lengthy study and permitting process, and construction of replacement facilities, would precede any decommissioning due to the essential and integral nature of these facilities with the western electric grid. Cumulative impacts regionally (within 300 km of NGS) would be major for ozone, and minor to major for acid deposition due to the additive effects of NGS and other sources. Maximum cumulative criteria pollutant impacts would be minor. Cumulative regional haze would be moderate.			Cumulative impacts would be slightly less than for the Proposed Action and dominated by non-project activities.	construction of any replacement facilities, would precede any decommissioning due to the essential and integral nature of these facilities with the western electric grid.
3.2 Climate and Climate Change	Future Project greenhouse gas emissions are estimated to range between 18.4 (3-unit) and 12.3 (2-unit) million metric tons per year over the period 2020-2044. Over this time frame, it is estimated that global greenhouse gas emissions would increase 52 percent because of increased energy demands, a major cumulative impact. Because NGS-KMC Project's greenhouse emissions would be constant, they would represent a declining share of the overall global increase.	Future Project greenhouse gas emissions are estimated to range between 17.9 and 17.1 (3-unit) and 11.8 and 11.0 (2-unit) million metric tons per year over the period 2020-2044. These emissions represent a 12 to 30 percent greenhouse gas reduction relative to the Proposed Action because natural gas-generated energy purchased from the market would be substituted for coal combustion at NGS.	Future Project greenhouse gas emissions are estimated to range between 17.9 and 17.1 (3-unit) and 11.8 and 11.0 (2-unit) million metric tons per year over the period 2020-2044. These emissions represent a 12 to 30 percent greenhouse gas reduction relative to the Proposed Action because renewable source-generated energy purchased from the market would be substituted for coal combustion at NGS.	Future Project greenhouse gas emissions are estimated to range between 18.1 and 17.6 (3-unit) and 12.0 and 11.5 (2-unit) million metric tons per year over the period 2020-2044. These emissions represent an 8 to 19 percent greenhouse gas reduction relative to the Proposed Action because renewable energy, generated from a photovoltaic solar facility on tribal land, would be substituted for coal combustion at NGS.	After NGS and the Kayenta Mine cease operations in 2019 under the 1969 lease and other existing arrangements, it is assumed that federal share replacement power for the CAP system would be provided by a natural gas combined cycle source. On this basis, 8.6 metric tons of greenhouse gases would be emitted, or 53 percent less than the Proposed Action 3-unit operation, and 30 percent less than the Proposed Action 2-unit operation.

Table ES-3 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.3 Geology	NGS and proposed KMC components and operations would not impact unique geologic features and would be exposed to minor risk from damage during an earthquake event from 2020 through 2044. Mining at proposed KMC and coal combustion disposal would result in minor impact to land forms. The WTS and STS would continue operations as described under the Air Quality Proposed Action and no impacts to unique geologic resources are anticipated. The WTS would be at minor risk of damage from earthquakes because of its proximity to active faults and higher potential ground motion during an earthquake.	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Impacts to unique geologic resources, land forms, and as a result of geologic hazards would be the same as the Proposed Action, except that 5 to 18 percent less mining surface disturbance would occur at the proposed KMC, resulting in less impact to land forms.	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Impacts to unique geologic resources, land forms, and as a result of geologic hazards would be the same as the Proposed Action, except that 3 to 10 percent less mining surface disturbance would occur at the proposed KMC, resulting in less impact to land forms.	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Geology resource impacts would be analyzed in a subsequent NEPA action. Impacts to unique geologic resources, land forms, and as a result of geologic hazards would be the same as the Proposed Action, except that 2 to 7 percent less mining surface disturbance would occur at the proposed KMC, resulting in less impact to land forms.	Demolition and mine closure after 2019 would have no impact to unique geologic resources and negligible impacts to land forms as a result of reclamation activities. Impacts to the WTS and STS are the same as described for the Air Quality No Action Alternative. The WTS would be at minor risk of damage from earthquakes because of its proximity to active faults and higher potential ground motion during an earthquake.
3.4 Minerals	Negligible project impacts to mineral resource availability because of the absence of known commercially extractable minerals except for coal at the proposed KMC. Coal resources at the proposed KMC would be adequate to meet NGS power generation commitments. The WTS and STS would	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Mineral resource occurrence and availability impacts would be the same as the Proposed Action, except that 5 to 18 percent less mining surface disturbance would occur at the proposed KMC.	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Mineral resource occurrence and availability impacts would be the same as the Proposed Action, except that 3 to 10 percent less mining surface disturbance would occur at the proposed KMC.	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Mineral resource impacts would be analyzed in a subsequent NEPA action. Mineral resource occurrence and availability impacts would be the same as the	Negligible impacts on mineral resources from decommissioning at NGS, BM&LP Railroad, and the Kayenta Mine after 2019. Impacts as described in the Proposed Action would not occur because coal extraction from 5,230 to 4,741 acres at Kayenta Mine after 2019 would not occur. Impacts to the WTS and STS are

Table ES-3 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
	continue operations as described under the Air Quality Proposed Action.			Proposed Action, except that 2 to 7 percent less mining surface disturbance would occur at the proposed KMC.	the same as described for the Air Quality No Action Alternative.
3.5 Paleonto-logical	Negligible project surface disturbance impacts to fossil resources because of the generally low to moderate fossil importance rank of the bedrock formations, and the recommended unanticipated discovery protection measure at proposed KMC. The WTS and STS would continue operations as described under the Air Quality Proposed Action.	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Paleontological resource impacts would be the same as the Proposed Action, except that 5 to 18 percent less mining surface disturbance would occur at the proposed KMC.	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Paleontological resource impacts would be the same as the Proposed Action, except that 3 to 10 percent less mining surface disturbance would occur at the proposed KMC.	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Paleontological resource impacts would be analyzed in a subsequent NEPA action. Paleontological resource impacts would be the same as the Proposed Action, except that 2 to 7 percent less mining surface disturbance would occur at the proposed KMC.	Negligible impacts on paleontological resources from decommissioning NGS, BM&LP Railroad, and the Kayenta Mine after 2019. Impacts as described in the Proposed Action would not occur because coal extraction from 5,230 to 4,741 acres at Kayenta Mine after 2019 would not occur. Impacts to the WTS and STS are the same as described for the Air Quality No Action Alternative.

Table ES-3 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.6 Soil	Moderate project soil surface disturbance impacts from 2020 to 2044 would range from 4,998 to 5,527 acres. Soils and suitable revegetation material would be salvaged and protected in accordance with federal regulatory programs and lease terms. Minor trace metal deposition impacts. Predicted trace metal deposition would not cause applicable EPA soil screening levels to be exceeded or contribute to unacceptable human or ecological risks. After 2044, 10,123 acres on NGS, the BM&LP Railroad, and the proposed KMC would require reapplication of soil or suitable revegetation materials and seeded. The WTS and STS would continue operations as described under the Air Quality Proposed Action. Proposed Action contributes 7 to 8 percent to estimated cumulative soil disturbance of 61,985 to 62,514 acres, a moderate cumulative impact.	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Moderate project soil disturbance impacts from 2020 to 2044 would be 5 to 18 percent less than the Proposed Action because less coal would be mined. Minor trace metal deposition impacts would be 5 to 19 percent less than the Proposed Action. Decommissioning after 2044 also would be proportionally less. Cumulative impacts slightly less than Proposed Action.	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Moderate project soil disturbance impacts from 2020 to 2044 would be 3 to 10 percent less than the Proposed Action because less coal would be mined. Minor trace metal deposition would be 2 to 12 percent less than the Proposed Action. Decommissioning after 2044 also would be proportionally less. Cumulative impacts slightly less than Proposed Action.	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Soil resource impacts would be analyzed in a subsequent NEPA action. Moderate project soil disturbance impacts from 2020 to 2044 would be 2 to 7 percent less than the Proposed Action because less coal would be mined. Minor trace metal deposition impacts would be 2 to 11 percent less than the Proposed Action. Decommissioning after 2044 also would be proportionally less. Cumulative impacts slightly less than Proposed Action.	Demolition and mine closure after 2019 would require topsoiling and seeding on 9,272 acres. Impacts to the WTS and STS are the same as described for the Air Quality No Action Alternative. Soil protection, and erosion and sediment control programs, and transmission line and communication site operation and maintenance activities would be the same as those described for the Proposed Action. Impacts to the WTS and STS are the same as described for the Air Quality No Action Alternative.

Table ES-3 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.7 Water	Moderate to negligible project impacts from 2020 to 2056 to surface water and groundwater water quantity and quality. Moderate impacts include modifications in surface flows in major washes downstream from the proposed KMC caused by changes in location and capacity of storage ponds. Minor project impacts include mine pumping drawdown of N-Aquifer utilized by nearby community wells, increases in community well pumping costs; and changes in water levels in the Wepo aquifer that may affect community surface water uses, and water quality. The Project is projected to contribute minor reductions in future N-Aquifer drawdown, but cumulative drawdown from all sources is predicted to be major (see No Action). The WTS and STS would continue operations as described under the Air Quality Proposed Action.	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Moderate and minor project impacts from 2020 to 2044 would be the same as the Proposed Action except that 5 to 18 percent less mining surface disturbance would occur at the proposed KMC, which may modify plans for stormwater retention. Proposed KMC groundwater pumping demands would remain the same. Cumulative impacts would be similar to the Proposed Action.	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Moderate and minor project impacts from 2020 to 2044 would be the same as the Proposed Action except that 3 to 10 percent less mining surface disturbance would occur at the proposed KMC, which may modify plans for stormwater retention. Proposed KMC groundwater pumping demands would remain the same. Cumulative impacts would be similar to the Proposed Action.	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Water resource impacts would be analyzed in a subsequent NEPA action. Moderate and minor project impacts from 2020 to 2044 would be the same as the Proposed Action except that 2 to 7 percent less mining surface disturbance would occur at the proposed KMC, which may modify plans for stormwater retention. Proposed KMC groundwater pumping demands would remain the same. Cumulative impacts would be similar to the Proposed Action.	By ceasing Kayenta Mine operations in 2019, mine drawdown impacts on nearby community wells and pumping costs would be negligible. Major to moderate N-Aquifer water level impacts are predicted as the result of community pumping through 2057 when up to 150 feet of drawdown is predicted. Major baseflow declines in Chinle Creek, Laguna Creek, and Polacca Wash would largely result from projected community pumping. Simulated reductions in flow at both monitored and non-monitored springs also are predicted to result from increases in community pumping over time. Impacts to the WTS and STS are the same as described for the Air Quality No Action Alternative.

Table ES-3 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.8 Vegetation	Moderate to negligible project impacts on vegetation. Moderate project vegetation removal impacts from 2020 to 2044 would range from 4,998 to 5,527 acres. Disturbed areas would be reseeded with approved mixtures, and monitored for release back to the Navajo Nation and Hopi Tribe. Re-establishment of grassland communities would require 5 years; shrublands and woodlands from 25 to 50 years. Minor project impacts from noxious weeds which could quickly expand across disturbed areas. Weed populations would be targets of ongoing control during reclamation. After 2044, 10,123 acres of project surface disturbance would require reapplication of soil followed by reseeding, and approved for release to the land owner. The WTS and STS would continue operations as described under the Air Quality Proposed Action. Project vegetation removal	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Moderate project vegetation removal impacts from 2020 to 2044 would be 5 to 18 percent less than the Proposed Action because less coal would be mined; decommissioning requirements also would be proportionally less. Moderate cumulative vegetation removal impacts would be slightly less than the Proposed Action because of less surface disturbance on the proposed KMC.	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Moderate project vegetation removal impacts from 2020 to 2044 would be 3 to 10 percent less than the Proposed Action because less coal would be mined; decommissioning requirements after 2044 would be proportionally less. Moderate cumulative vegetation removal impacts would be slightly less than the Proposed Action because of less surface disturbance on the proposed KMC.	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Vegetation resource impacts would be analyzed in a subsequent NEPA action. Moderate project vegetation removal impacts from 2020 to 2044 would be 2 to 7 percent less than the Proposed Action because less coal would be mined; decommissioning requirements after 2044 also would be proportionally less. Moderate cumulative vegetation removal impacts would be slightly less than the Proposed Action because of less surface disturbance on the proposed KMC.	Demolition and mine closure after 2019 would require seeding on 9,272 acres. Seeding requirements would be the same as those for the Proposed Action. Negligible impacts to native riparian communities in major washes near Kayenta Mine from community pumping because of predicted reductions in baseflows, Primary areas of concern are Chinle Creek, Laguna Creek, and Polacca Wash, where native riparian vegetation communities are not present, or are extremely small and isolated. Impacts to the WTS and STS are the same as described for the Air Quality No Action Alternative.

Table ES-3 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.8 Vegetation (continued)	impacts from 2020-2044 would contribute 7 to 8 percent of up to 61,985 to 62,514 acres of moderate cumulative vegetation removal impacts.				
3.9 Special Status Vegetation Resources	Negligible project impacts on special status plants. Negligible potential surface disturbance impacts to special status plants from O&M activities in transmission line ROW; negligible loss of special status plants and populations from project new surface disturbance, and N-Aquifer drawdown. The WTS and STS would continue operations as described under the Air Quality Proposed Action. Minor cumulative risks for loss of special status plants from foreseeable utility construction activities adjacent to, or near the WTS ROW.	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Negligible project impacts on special status plants. Minor cumulative risks for loss of special status plants from foreseeable utility construction activities adjacent to, or near the WTS ROW.	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Negligible project impacts on special status plants. Minor cumulative risks for loss of special status plants from foreseeable utility construction activities adjacent to, or near the WTS ROW.	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Special status vegetation impacts would be analyzed in a subsequent NEPA action. Negligible project impacts on special status plants. Minor cumulative risks for loss of special status plants from foreseeable utility construction activities adjacent to, or near the WTS ROW.	Impacts to the WTS and STS are the same as described for the Air Quality No Action Alternative. O&M activities would occur along transmission line access roads, and periodic repairs may be required. Negligible risk of special status plant disturbance.
3.10 Terrestrial Wildlife	Moderate to negligible impacts to wildlife habitat and populations. Moderate impacts on wildlife habitat from vegetation removal; moderate impacts from direct losses of individuals from collisions, and electrocution; habitat avoidance impacts from human activities	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Moderate habitat removal impacts from 2020 to 2044 would be 5 to 18 percent less than the Proposed Action	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Moderate habitat removal impacts from 2020 to 2044 would be 3 to 10 percent less than the Proposed Action	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Terrestrial wildlife impacts would be analyzed in a subsequent NEPA action.	From 4,998 to 5,527 acres of shrubland and woodland vegetation at NGS and Kayenta Mine would not be removed by coal mining. Impacts to the WTS and STS are the same as described for the Air Quality No Action Alternative.

Table ES-3 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.10 Terrestrial Wildlife (continued)	at the proposed KMC (traffic, lighting, noise). The WTS and STS would continue operations as described under the Air Quality Proposed Action. Moderate cumulative impacts due to regional habitat removal, foreseeable construction near the WTS.	because less coal would be mined. Direct animal losses and human activity levels would be the same as the Proposed Action. Moderate cumulative impacts would be slightly less than the Proposed Action because of reduced mining surface disturbance (see Vegetation).	because less coal would be mined. Direct animal losses and human activity levels would be the same as the Proposed Action. Moderate cumulative impacts would be slightly less than the Proposed Action because of reduce mining surface disturbance (see Vegetation).	Moderate habitat removal impacts from 2020 to 2044 would be 2 to 7 percent less than the Proposed Action because less coal would be mined. Direct animal losses and human activity levels would be the same as the Proposed Action. Moderate cumulative impacts would be slightly less than the Proposed Action because of reduce mining surface disturbance (see Vegetation).	
3.11 Special Status Wildlife Resources	Minor project impacts to individuals of the Mexican spotted owl from mining-related noise and lighting; minor impacts to Mojave and Sonoran desert tortoise from vehicle collisions during WTS and STS O&M activities. The WTS and STS would continue operations as described under the Air Quality Proposed Action. Cumulative effects minor to moderate on Mojave desert tortoise, southwest willow flycatcher, and yellow-billed cuckoo due to foreseeable transmission line and water	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Minor project impacts to special status species, same as Proposed Action. Cumulative impacts to the Mexican Spotted Owl, Mojave Desert Tortoise, Southwestern Willow Flycatcher, and yellow-billed Cuckoo would be same as the Proposed Action.	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Minor project impacts to special status species, same as Proposed Action. Cumulative impacts to the Mexican Spotted Owl, Mojave Desert Tortoise, Southwestern Willow Flycatcher, and yellow-billed Cuckoo would be same as the Proposed Action.	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Special status wildlife impacts would be analyzed in a subsequent NEPA action. Minor project impacts to special status species, same as Proposed Action. Cumulative impacts to the Mexican Spotted Owl, Mojave Desert Tortoise, Southwestern Willow Flycatcher, and yellow-billed Cuckoo would be same as the Proposed Action.	From 4,998 to 5,527 acres of shrubland and woodland vegetation at NGS and Kayenta mine would not be removed by coal mining, resulting in lower human activity impacts on the Mexican spotted owl. Vehicle collisions risk for Mojave and Sonoran Desert Tortoise would be same because foreseeable construction projects adjacent to the WTS would likely occur; Impacts to the WTS and STS are the same as described for the Air Quality No Action Alternative. O&M activities along the WTS and STS would continue, unless full decommissioning occurs.

Table ES-3 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
	pipeline construction.				
3.12 Aquatic Biological Resources	Minor to negligible NGS trace metal deposition impacts on aquatic community constituents and water quality. The combination of baseline concentrations with very small project contributions would result in a minor risk of selenium effects on fish populations in the San Juan River and the Colorado River below Glen Canyon Dam. Minor impacts to aquatic species due to elevated metals concentrations that exceed toxicity thresholds in proposed KMC surface waterbodies, primarily from background sources. Groundwater pumping for the proposed KMC Proposed Action would contribute less than 1 percent reduction in Begashibito Wash, resulting in minor changes in aquatic habitat where surface flows are present. The WTS and STS would continue operations as described under the Air Quality Proposed Action.	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. NGS trace metal impacts would be the same as the Proposed Action, except NGS stack emissions would be 5 to 19 percent less. Cumulative impacts from trace metals deposition, and cumulative groundwater pumping impacts on aquatic habitats would be the same as the Proposed Action.	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. NGS trace metal impacts on fisheries would be the same as the Proposed Action, except NGS stack emissions would be 3 to 11 percent less. Cumulative impacts from trace metals deposition, and cumulative groundwater pumping impacts on aquatic habitats would be the same as the Proposed Action.	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Aquatic biological resource impacts would be analyzed in a subsequent NEPA action. NGS trace metal impacts on fisheries would be the same as the Proposed Action, except NGS stack emissions would be 2 to 8 percent less. Cumulative impacts from trace metals deposition, and cumulative groundwater pumping impacts on aquatic habitats would be the same as the Proposed Action.	The elimination of current NGS emissions would subtract a very small emission level from existing baseline conditions. There would be continued minor deposition impacts from mercury and selenium in the Colorado River below Glen Canyon Dam, and selenium in the San Juan River on some nongame fish species. Because the elimination of emission effects from the proposed KMC facilities would be very small, the resulting metal concentrations in waterbodies would be negligible. Continued minor impacts to aquatic species due to elevated metals concentrations that exceed toxicity thresholds in Kayenta Mine surface waterbodies, primarily from background sources. Community pumping would result in base flow reductions of approximately 8 to 22 percent in Polacca, Chinle, and Begashibito washes and Laguna Creek, which would cause moderate reductions in aquatic habitat and aquatic invertebrates where surface water is present. Impacts to the WTS and STS are

Table ES-3 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.12 Aquatic Biological Resources (continued)	NGS future operations would contribute a small fraction of the total cumulative fish tissue concentrations. Cumulative deposition of mercury and selenium in the Colorado River below Glen Canyon Dam and in the San Juan River present a potential risk to fish populations. Global and other regional sources are the main contributors to metal effects.				the same as described for the Air Quality No Action Alternative.
3.13 Special Status Aquatic Biological Species	Minor trace metal deposition impacts based on the low number of fish that could be injured and the small percentage of fish population numbers potentially affected. Minor project impacts (measured by tissue concentrations) to fish individuals of Colorado pike minnow, razorback sucker, and humpback chub from NGS trace metal contributions combined with baseline concentrations. Minor impacts on critical habitat for Colorado pikeminnow and razorback sucker in the San Juan River and humpback chub and razorback sucker in the Colorado River below Glen Canyon Dam, because of historical small baseline exceedances of mercury and	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. NGS trace metal impacts would be the same as the Proposed Action, except NGS stack emissions would be 5 to19 percent less. Cumulative impacts from trace metals deposition would be nearly the same as the Proposed Action.	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. NGS trace metal impacts would be the same as the Proposed Action, except NGS stack emissions would be 3 to 11 percent less. Cumulative impacts from trace metals deposition would be nearly the same as the Proposed Action.	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Special status aquatic biological resource impacts would be analyzed in a subsequent NEPA action. NGS trace metal impacts would be the same as the Proposed Action, except NGS stack emissions would be 2 to 8 percent less. Cumulative impacts from trace metals deposition would be nearly the same as the Proposed Action.	Elimination of current NGS emissions after 2019 would subtract a very small emission level from existing baseline conditions. Potential risks to special status species would occur in the Colorado River below Glen Canyon Dam and San Juan River due to baseline fish tissue concentrations. There would be a minor effect on the water element of critical habitat for humpback chub and razorback sucker in the Colorado River below Glen Canyon Dam and Colorado pikeminnow and razorback sucker in the San Juan River, based on historical exceedances of mercury or selenium water quality standards. Impacts to the WTS and STS are the same as described for the Air Quality No Action Alternative.

Table ES-3 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.13 Special Status Aquatic Biological Species (continued)	selenium water quality standards. The WTS and STS would continue operations as described under the Air Quality Proposed Action. Minor cumulative impacts (based on life stage injury estimates) of mercury to individuals of Colorado pikeminnow in the San Juan River; moderate impacts of mercury on humpback chub individuals and critical habitat in the Colorado River below Glen Canyon Dam; moderate impacts to razorback sucker individuals and critical habitat in the Colorado River below Glen Canyon Dam and in the San Juan River. Project emissions contributions to mercury concentrations in fish tissue are estimated to be 0.1 to 0.2 percent.				
3.14 Land Use	Moderate project land use impacts, almost entirely from continued mining on proposed KMC. Vegetation removal impacts from 2020 to 2044 would range from 4,998 to 5,527 acres. Area of surface disturbance requiring reclamation after 2044 is 10,123 acres. Disturbed areas	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Moderate project land use impacts would be the same as the Proposed Action except that 5 to 18 percent less	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Moderate project land use impacts would be the same as the Proposed Action except that 3 to 10 percent less	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Land use impacts would be analyzed in a subsequent NEPA action.	From 4,998 to 5,527 acres of shrubland and woodland vegetation at NGS and Kayenta Mine would not be removed by coal mining, and would be available for grazing and other uses. Once decommissioning and reclamation activities are complete after 2019, the NGS site, BM&LP Railroad ROW, and

Table ES-3 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.14 Land Use (continued)	would be reseeded with approved mixtures, and monitored for release back to the Navajo Nation and Hopi Tribe. Incremental reduction or removal of four to five grazing areas would reduce livestock grazing capacity. Residential relocations from mining areas would be a moderate impact because the residents are compensated.	surface disturbance at the proposed KMC would occur because less coal would be mined, which may change number of residents that would require relocation.	surface disturbance at the proposed KMC would occur because less coal would be mined, which may change number of residents that would require relocation.	Moderate project land use impacts would be the same as the Proposed Action except that 2 to 7 percent less surface disturbance at the proposed KMC would occur because less coal would be mined, which may change number of residents that would require relocation.	Kayenta Mine would be returned to the Navajo Nation and Hopi Tribe. Impacts to the WTS and STS are the same as described for the Air Quality No Action Alternative.
3.15 Public Safety	Minor to negligible project public safety impacts because the public is excluded from the industrial activity areas of the NGS and the proposed KMC. Residents within the proposed KMC lease boundary would be exposed to equipment noise, periodic blasting, mine traffic, and potential hazardous spills Planning and implementation of best management practices would reduce impacts from potential spills. Notice of blasting activity is provided in advance and residential relocation programs are initiated when mining encroaches within the safety zone around residences. The WTS and STS would continue operations as described under the	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Minor to negligible project public safety impacts would be the same as the Proposed Action except that 5 to 18 percent less surface disturbance at proposed KMC would occur because less coal would be mined, which may change the number of residents that would require relocation, and change the residence exposure distance to potential spills, noise and fugitive dust sources.	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Minor to negligible project public safety impacts would be the same as the Proposed Action except that 3 to 10 percent less surface disturbance at proposed KMC would occur because less coal would be mined, which may change the number of residents that would require relocation, and change the residence exposure distance to potential spills, noise and fugitive dust sources.	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Public safety impacts would be analyzed in a subsequent NEPA action. Minor to negligible project public safety impacts would be the same as the Proposed Action except that 2 to 7 percent less surface disturbance at proposed KMC would occur because less coal would be mined, which may change the number of residents that would require relocation, and change the residence exposure distance to potential spills, noise and fugitive dust sources.	Mine reclamation activities would continue after 2019, but no active surface mining. Residential relocations, noise disturbance, and other impacts as described in the Proposed Action and action alternatives in the proposed mining areas would not occur.

Table ES-3 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
	Air Quality Proposed Action.				
3.16 Public Health and Human Health Risk	Human health risks from project component emissions are negligible because potential cancer and non-cancer risks are considered acceptable based on human health risk assessments. Project operations would result in minor or negligible health impacts to the general population. Major project benefits to public health result from long-term employment at NGS and the proposed KMC and opportunities for health care. These benefits are offset by minor emotional stress caused by relocation of residents and the indirect health effects associated with proximity to mining noise and equipment activity. The WTS and STS would continue operations as described under the Air Quality Proposed Action. Based on an unacceptable non-cancer hazard of 2 for the ingestion of Lake Powell fish by the recreational user, a minor impact on human health was identified. The impact is	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Negligible project human health risks and minor to negligible health impacts would be the same as the Proposed Action except that 5 to 18 percent less surface disturbance would occur because of less coal mining, resulting in less exposure to fugitive dust over the long term. Minor Lake Powell fish ingestion hazards would be the same as the Proposed Action.	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Negligible project human health risks and minor to negligible health impacts would be the same as the Proposed Action except that 3 to 10 percent less surface disturbance would occur because of less coal mining, resulting in less exposure to fugitive dust over the long term. Minor Lake Powell fish ingestion hazards would be the same as the Proposed Action.	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Impacts to public health and human health risks would be analyzed in a subsequent NEPA action. Negligible project human health risks and minor to negligible health impacts would be the same as the Proposed Action except that 2 to 7 percent less surface disturbance would occur because of less coal mining, resulting in less exposure to fugitive dust over the long term. Minor Lake Powell fish ingestion hazards would be the same as the Proposed Action.	Human exposure to NGS stack emissions would cease after 2019. Dust emissions from decommissioning and reclamation activities at NGS would occur over a 1-year period, and over a minimum of 10 years at the Kayenta Mine, a negligible human health impact. Closure of the Kayenta Mine after 2019 would eliminate public exposure to mine traffic, equipment noise, and blasting. The loss of jobs at both NGS and the Kayenta Mine would result in increased stress for unemployed workers and their families and potential loss of health benefits. This constitutes a major impact on public health. Minor Lake Powell fish ingestion hazards would be the same as the Proposed Action. Impacts to the WTS and STS are the same as described for the Air Quality No Action Alternative.

Table ES-3 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.16 Public Health and Human Health Risk (continued)	considered minor because of the fish advisory (Arizona Game and Fish Department 2012) that likely limits the consumption of fish. NGS trace metal contributions to this hazard would be negligible.				
3.17 Cultural Resources	Major to negligible impacts to cultural resources from surface mining at the proposed KMC. Moderate to major impacts from discovery and repatriation of human burials within areas to be mined; moderate impacts to archeological and architectural sites; negligible to major impacts to Traditional Cultural Properties, which are places important for traditional uses or religious values. Cultural resources potentially directly affected consist of 195 to 214 archaeological sites. 15 Traditional Cultural Properties; and 13 human remains. Two Programmatic Agreements developed for the NGS-KMC Project address cultural resource impacts for all project components and direct the responsible federal agencies to consult with federal, state, Tribal, municipal, and private landowners to address Section 106 requirements.	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Major to negligible impacts to cultural resources from surface mining at proposed KMC. Direct impacts to cultural resources would be similar to the Proposed Action, but cannot be quantified because specific future mining plans have not yet been developed. Negligible to major cumulative risks for cultural resource disturbance from foreseeable utility construction activities adjacent to, or near the WTS ROW.	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Major to negligible impacts to cultural resources from surface mining at the proposed KMC. Direct impacts to cultural resources would be similar to the Proposed Action, but cannot be quantified because specific future mining plans have not yet been developed. Negligible to major cumulative risks for cultural resource disturbance from foreseeable utility construction activities adjacent to, or near the WTS ROW.	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Cultural resource impacts would be analyzed in a subsequent NEPA action. Major to negligible impacts to cultural resources from surface mining at the proposed KMC. Direct impacts to cultural resources would be similar to the Proposed Action, but cannot be quantified because specific future mining plans have not yet been developed. Negligible to major cumulative risks for cultural resource disturbance from foreseeable utility construction activities adjacent to, or near the WTS ROW.	Project impacts to historic properties listed in or potentially eligible for listing in the NRHP would not occur. Potential impacts to cultural resources of any type would take place during the decommissioning phase of the project. Any future undertakings, such as decommissioning and reclamation, would be addressed through the standard regulatory process (36 CFR 800) by the appropriate federal agency. Impacts to the WTS and STS are the same as described for the Air Quality No Action Alternative.

Table ES-3 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.17 Cultural Resources (continued)	The WTS and STS would continue operations as described under the Air Quality Proposed Action. Negligible to major cumulative risks for cultural resource disturbance from foreseeable utility construction activities adjacent to or near the WTS ROW.				
3.18 Socio-economics	Major economic impacts are associated with the continuation of the NGS-KMC Project. These include providing 2,745 to 3,812 jobs, approximately 187 to 260 million dollars in labor income, and estimated project-related payments to tribes of 1.8 to 2.5 billion over the 25-year period. A continued employment base would provide long-term social stability, and allow the younger generation members to remain in their communities. Concerns about the long-term commitment to coal as a source of electrical energy, public health, water supply availability, residential relocations, and grazing land availability would continue.	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Major economic impacts are associated with continuation of the NGS-KMC Project. NGS and proposed KMC employment and labor income would be between 4 and 10 percent lower compared to the Proposed Action. These labor income and employment reductions would be major impacts because of the lack of revenue replacement opportunities. Project operations would provide long-term social stability, and concerns about commitment to coal as an energy source, and impacts to public health and land use	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Major economic impacts are associated with continuation of the NGS-KMC Project. NGS and proposed KMC employment and labor income would be between 3 and 6 percent lower compared to the Proposed Action. These labor income and employment reductions would be major impacts because of the lack of revenue replacement opportunities. Project operations would provide long-term social stability, and concerns about commitment to coal as an energy source, and impacts to public health and land use	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Socioeconomic impacts would be analyzed in a subsequent NEPA action. Major economic impacts are associated with continuation of the NGS-KMC Project. NGS employment and labor income would be between 3 and 7 percent lower compared to the Proposed Action. These labor income and employment reductions would be major impacts because of the lack of revenue replacement opportunities. Short-term employment (1 to 3 years) providing 550 to 650 construction jobs would provide a minor income and	Major economic and social impacts would occur if NGS and the Kayenta Mine ceased operations after 2019. It is estimated that 3,090 jobs would be immediately lost, with a reduction in labor income of $234 million per year, as well as long-term retirement and pension income. Community contributions and scholarships provided by NGS and Kayenta Mine operators of approximately $700,000 per year; payments to the Navajo electrical utility; and PWCC contributions to abandoned mine and black lung funds would cease. Fiscal impacts would be major because of the very large contribution of NGS and the Kayenta Mine to the Navajo and Hopi government revenues, and the high proportion of tribal

Table ES-3 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.18 Socio-economics (continued)	The WTS and STS would continue operations as described under the Air Quality Proposed Action. Pumping energy costs to CAP are expected to increase by 20 to 23 percent, as compared to 2016 base rate of $76 per acre-foot of water delivered (Agricultural Settlement Pool). This increase is considered a minor to moderate impact to agricultural water users. The contributions of the project to cumulative socioeconomic effects would be moderate to major because the incomes for residents and payments to the Navajo Nation and Hopi are substantial and would provide a measure of revenue stability at a time when revenues from other sources may decline.	would continue. Pumping energy costs to CAP would increase by between 45 and 112 percent as compared to 2016 base rate of $76 per acre-foot of water delivered (Agricultural Settlement Pool). This increase is considered a moderate to major impact to users. The contributions of the project to cumulative socioeconomic impacts would be moderate to major, same as the Proposed Action.	would continue. Pumping energy costs to CAP would increase by between 36 and 68 percent as compared to 2016 base rate of $76 per acre-foot of water (Agricultural Settlement Pool). This increase is considered a minor to major impact to users. The contributions of the project to cumulative socioeconomic impacts would be moderate to major, same as the Proposed Action.	employment benefit. Project operations would provide long-term social stability, and concerns about commitment to coal as an energy source, and impacts to public health, cultural resources, and land use would continue. Pumping energy costs to CAP would increase by between 36 and 68 percent as compared to 2016 base rate of $76 per acre-foot of water delivered (Agricultural Settlement Pool). This increase is considered a minor to major impact to users. The contributions of the project to cumulative socioeconomic impacts would be moderate to major, same as the Proposed Action.	workers at both facilities. Rising unemployment would likely require many workers and their families to leave Page, Kayenta, and other nearby Navajo chapters for employment opportunities elsewhere. Economic hardship for local business would likely increase from the loss of power plant and mine employment. Project-related concerns about public health, cultural resources, and land use would diminish. Pumping energy costs to CAP could result in energy costs between 19 percent lower and 18 percent more costly as compared to 2016 base rate of $76 per acre-foot of water delivered (Agricultural Settlement Pool). This range is largely dictated by changes in natural gas prices. Costs of agricultural production may increase, resulting in less income to farmers. No excess generation income would be provided by NGS, and therefore no contributions to the Development Fund. Impacts to the WTS and STS are the same as described for the Air

Table ES-3 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
					Quality No Action Alternative.
3.19 Environmental Justice	Residents living within and immediately adjacent to the proposed KMC who are part of the Environmental Justice population on the Navajo Nation would experience disproportionately high sociocultural impacts and minor to moderate human health impacts. No disproportionately high and adverse sociocultural or human health impacts to any other environmental justice populations would be anticipated. The WTS and STS would continue operations as described under the Air Quality Proposed Action. No disproportionately high and adverse air quality, water resources, ecological, or safety impacts to any environmental justice population would be anticipated.	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Environmental justice impacts would be the same as the Proposed Action.	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Environmental justice impacts would be the same as the Proposed Action.	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Environmental Justice issues would be analyzed in a subsequent NEPA action. Environmental justice impacts would be the same as the Proposed Action.	Major economic and social impacts including the loss of over 3,000 total jobs, many of which are currently held by Navajo and Hopi workers. The loss of revenues from NGS and the Kayenta Mine to the Navajo Nation and Hopi Tribe would reduce services and employment on the two reservations that would represent a major, long-term impact for the two tribes. Employment losses would have corresponding social effects and potentially result in relocation for affected Navajo and Hopi families or wage earners. These economic and social impacts would be considered major, and they would accrue disproportionately to the Navajo Nation and Hopi Tribe, which are environmental justice populations identified for this EIS.

Table ES-3 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.20 Indian Trust Assets	Minor to negligible impacts would be anticipated to Navajo Nation and Hopi Tribe Indian trust assets. The impacts on land, water, and mineral trust assets would be offset by the negotiated compensations and protection measures provided by lease and ROW agreements, environmental regulations, plans, and programs (e.g., Coal Combustion Residuals Rule, Groundwater Protection Plan), No impacts to land trust assets of the Kaibab Band of Paiute Indians or Moapa Band of Paiute Indians related to the transmission systems and communication sites. The WTS and STS would continue operations as described under the Air Quality Proposed Action. No impact on water rights trust assets for the CAP-affected tribes. Higher energy costs for pumping CAP water and associated effects of higher costs on deposits to the Development Fund could affect economics of CAP water utilization for some CAP-	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Project impacts on Indian trust assets for the Navajo Nation, Hopi Tribe, Kaibab Band of Paiute Indians, and Moapa Band of Paiute Indians would be the same as the Proposed Action. No impact on water rights Indian trust assets for the CAP-affected tribes (same as the Proposed Action). Pumping energy costs could be higher or lower than those under the Proposed Action, depending on the future price of natural gas. This potentially could affect deposits to the Development Fund and the economics of CAP water utilization for some CAP-affected tribes.	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Project impacts on Indian trust assets for the Navajo Nation, Hopi Tribe, Kaibab Band of Paiute Indians, and Moapa Band of Paiute Indians would be the same as the Proposed Action. No impact on water rights Indian trust assets for the CAP-affected tribes (same as the Proposed Action). Pumping energy costs would be higher than those under the Proposed Action, depending on the future price of natural gas. This potentially could affect deposits to the Development Fund and the economics of CAP water utilization for some CAP-affected tribes.	The Tribal PFR Alternative assumes a new, but unidentified site(s) between 3,000 and 1,200 acres on tribal lands. The affected tribe would receive financial compensation and could negotiate for other measures to address impacts on Indian trust assets. Site-specific impacts on Indian trust assets would be analyzed in a subsequent NEPA action. Project impacts of NGS, the proposed KMC, transmission systems, and communications sites on Indian trust assets for the Navajo Nation, Hopi Tribe, Kaibab Band of Paiute Indians, and Moapa Band of Paiute Indians would be the same as the Proposed Action. No impact on water rights Indian trust assets for the CAP-affected tribes (same as the Proposed Action). Pumping energy costs would be higher than those under the Proposed Action, potentially affecting deposits to the Development Fund and the economics of CAP	No negative impacts to Indian trust assets of the Navajo Nation or Hopi Tribe would be anticipated. However, payments from 2020 to 2044 from NGS (totaling $793 million to $1.07 billion to the Navajo Nation) and from the proposed KMC (combined total to the Navajo Nation and Hopi Tribe from $787 million to $1.16 billion) for the use of water, land, and mineral Indian trust assets would be foregone compared to the Proposed Action. Impacts to the WTS and STS are the same as described for the Air Quality No Action Alternative. No impacts from continued operations and maintenance of the WTS, STS, and communications sites to Indian trust land assets of the Kaibab Band of Paiute Indians or Moapa Band of Paiute Indians. No impact on water rights Indian trust assets for the CAP-affected tribes (same as the Proposed Action). Pumping energy costs for CAP water under No Action could result in energy costs of between

Table ES-3 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.20 Indian Trust Assets (continued)	affected tribes.			water utilization for some CAP-affected tribes.	23 percent lower and 21 percent higher than under the Proposed Action, depending on the future price of natural gas. Deposits into the Development Fund would cease. The effects could affect the economics of CAP water utilization for some CAP-affected tribes.

Chapter 1.0

Purpose and Need for the Proposed Action

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Acronyms and Abbreviations

1969 Lease	Navajo Project Indenture of Lease
BART	Best Available Retrofit Technology
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BM&LP Railroad	Black Mesa & Lake Powell Railroad
BO	Biological Opinion
CAP	Central Arizona Project
CEQ	Council on Environmental Quality
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
CO_2	carbon dioxide
Co-tenants	Salt River Project, Arizona Public Service, NV Energy, and Tucson Electric Power Company
Development Fund	Lower Colorado River Basin Development Fund
EIS	Environmental Impact Statement
ERA	Ecological Risk Assessment
ESA	Endangered Species Act of 1973
HHRA	Human Health Risk Assessment
km	kilometer
KMC	Kayenta Mine Complex
kV	kilovolt
kW	kilowatt
MW	megawatt
N-Aquifer	Navajo Aquifer
NEPA	National Environmental Policy Act of 1969, as amended
NGS	Navajo Generating Station
NGS Participants	U.S. (Reclamation), Salt River Project, Arizona Public Service, NV Energy, and Tucson Electric Power Company
NHPA	National Historic Preservation Act
NNEPA	Navajo Nation Environmental Protection Agency
NO_2	nitrogen dioxide
NO_X	nitrogen oxide
OSMRE	Office of Surface Mining Reclamation and Enforcement
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 microns or less
PFR	Partial Federal Replacement
PWCC	Peabody Western Coal Company
Reclamation	U.S. Bureau of Reclamation
ROW	Right-of-way
SMCRA	Surface Mining Control and Reclamation Act of 1977
SO_2	sulfur dioxide

SRP	Salt River Project Agricultural Improvement and Power District
STS	Southern Transmission System
U.S.	United States
USC	United States Code
USEPA	U.S. Environmental Protection Agency
WTS	Western Transmission System

Contents

1.0 Purpose and Need for the Proposed Action ... 1-1
1.1 Introduction ... 1-1
1.2 Project Location ... 1-8
1.3 Project Background ... 1-8
1.4 Prior Relevant National Environmental Policy Act Compliance ... 1-10
1.4.1 Navajo Generating Station and Related Facilities ... 1-10
1.4.2 Navajo Generating Station Water Intake Structure Project ... 1-11
1.4.3 Navajo Generating Station Water Service Contract ... 1-11
1.4.4 Black Mesa-Kayenta Mine ... 1-12
1.5 Background for the Federal Agencies' Purpose and Need ... 1-13
1.5.1 Federal Agencies' Purpose and Need ... 1-20
1.6 Non-federal Entities ... 1-22
1.6.1 Non-federal Agency Actions ... 1-22
1.6.2 Non-federal Project Proponents' Interests, Goals, and Objectives ... 1-22
1.7 Historical Operations ... 1-22
1.7.1 Navajo Generating Station and Associated Facilities ... 1-22
1.7.1.1 Coal Storage and Handling ... 1-23
1.7.1.2 Power Generation ... 1-23
1.7.1.3 Air Pollution Control Systems ... 1-25
1.7.1.4 Water Delivery, Use, and Treatment ... 1-25
1.7.1.5 Roadways and Traffic ... 1-27
1.7.1.6 Fuel and Chemical Storage and Use ... 1-27
1.7.1.7 Landfills and Waste Management ... 1-28
1.7.1.8 Railroad and Coal Delivery to the Navajo Generating Station ... 1-31
1.7.2 Proposed Kayenta Mine Complex ... 1-33
1.7.2.1 Kayenta Mining and Mine Support Facilities ... 1-33
1.7.2.2 Former Black Mesa Mine and Mine Support Facilities ... 1-45
1.7.3 Transmission Systems and Communication Sites ... 1-47
1.8 Relationship of this Proposed Action to Other Activities ... 1-49
1.8.1 U.S. Environmental Protection Agency Actions ... 1-49
1.8.2 Joint Federal Agency Work Group ... 1-50
1.8.3 California and Nevada Legislation Regarding Use of Fossil Fuels ... 1-51
1.8.4 Navajo Nation Option to Acquire an Ownership Interest in Navajo Generating Station ... 1-52
1.8.5 Navajo Nation Primacy ... 1-52
1.9 Government-to-government Consultations ... 1-52
1.10 Public Scoping ... 1-53
1.10.1 Public Scoping Outreach Process ... 1-53
1.10.2 Public Scoping Meetings ... 1-54

1.10.3 Additional Meetings on the Hopi Reservation ... 1-54
1.10.4 Public Scoping Participation ... 1-54
1.10.5 Public Scoping Comments ... 1-54
1.11 Summary of Issues ... 1-55
1.12 Document Organization ... 1-57
1.13 References ... 1-63

List of Appendices

Appendix 1A - Synopsis of Documents

Appendix 1B - Navajo Project Operation and Maintenance Plan

Appendix 1C - BART-Federal Implementation Plan and Technical Working Group

Appendix 1D - Proposed KMC Information

Appendix 1E - Scoping Report

List of Tables

Table 1-1 Preliminary List of Federal Actions for the NGS-KMC Project 1-15
Table 1-2 Acreage of Support Operations at NGS 1-23
Table 1-3 Historical Chemical Delivery to NGS 1-28
Table 1-4 Summary of Landfills at NGS 1-28
Table 1-5 Production Volumes through 2019 (from March 27, 2015 Life-of-Mine Plan Significant Revision) 1-35
Table 1-6 Permitted Mine Support Facilities 1-36
Table 1-7 Former Black Mesa Mine Facilities in Use for Kayenta Mine through 2019 1-36
Table 1-8 Permitted Water Use and Management Facilities at the Proposed KMC 1-38
Table 1-9 Surface Ownership/Management for Lands Crossed by WTS and STS 1-47
Table 1-10 Government–to–Government Tribal Consultations to Date 1-53
Table 1-11 Commenter Type or Affiliation 1-55
Table 1-12 Public Scoping Comments on the Proposed Action and Alternatives Development 1-58
Table 1-13 Public Scoping Resource Issues Addressed in the EIS 1-60

List of Figures

Figure 1-1 General Project Location 1-2
Figure 1-2 NGS Participants' Interest Percentages 1-3
Figure 1-3 Navajo Generating Station Facilities 1-4
Figure 1-4 Proposed KMC Permit Area 1-6
Figure 1-5 Proposed KMC Coal Resource Areas 1-14
Figure 1-6 NGS Process Flow Diagram 1-24
Figure 1-7 One of Six Cooling Towers at Navajo Generating Station 1-26
Figure 1-8 NGS Ash Disposal Site 1-30
Figure 1-9 BM&LP Railroad from Kayenta Mine to NGS 1-32
Figure 1-10 Historical Operations Mining Areas through 2019 1-34
Figure 1-11 Historical Operations Roads and Facilities 1-37
Figure 1-12 Historical Operations Water Wells, Supply Pipelines, and Freshwater Ponds 1-40
Figure 1-13 Historical Operations Air Quality, Meteorological and Precipitation Monitoring Locations 1-44
Figure 1-14 Transmission Systems and Communication Sites 1-48

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1.0 Purpose and Need for the Proposed Action

1.1 Introduction

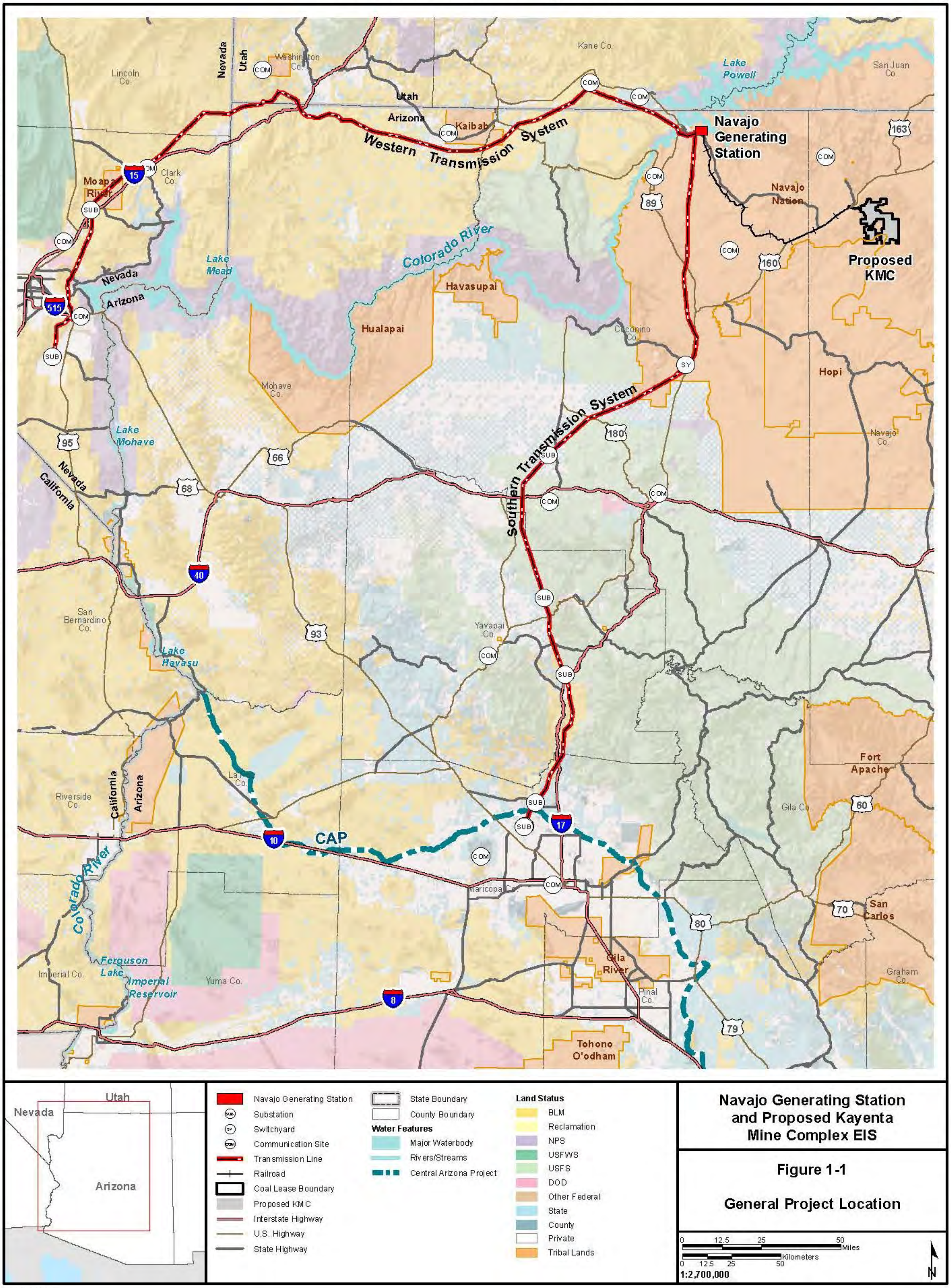
This Draft Environmental Impact Statement (EIS) describes the potential environmental impacts from the proposed continued operations of the Navajo Generating Station (NGS) and Kayenta Mine (**Figure 1-1**) for an additional 25 years, from December 23, 2019, through December 22, 2044, plus sufficient time for decommissioning of the NGS plant and its associated facilities and reclamation of the proposed Kayenta Mine Complex (KMC) (the Proposed Action). The lease under which NGS currently operates will expire on December 22, 2019.

The EIS evaluates the environmental effects of the Proposed Action, three action alternatives, and a No Action Alternative. It has been prepared in compliance with the requirements of the National Environmental Policy Act of 1969, as amended (NEPA) (Public Law 91-190), Council on Environmental Quality (CEQ) regulations for implementing NEPA (40 Code of Federal Regulations [CFR] Parts 1500-1508), and U.S. Department of the Interior regulations implementing NEPA (43 CFR Part 46).

The United States (U.S.) Department of the Interior's Bureau of Reclamation (Reclamation) is the lead federal agency for purposes of complying with NEPA, Section 7 of the Endangered Species Act (ESA), and Section 106 of the National Historic Preservation Act (NHPA). Due to the substantial jurisdictional responsibilities of both the Office of Surface Mining Reclamation and Enforcement (OSMRE) and Bureau of Indian Affairs (BIA), these two agencies have been defined as a "key cooperating agency;" Reclamation has worked closely with both OSMRE and BIA in preparing this Draft EIS (see Section 1.5.1 for additional explanation regarding these agencies' roles and responsibilities).

The project area for the Proposed Action encompasses a large area of northern Arizona, with other portions falling within southern Nevada, southwestern Utah, and central Arizona (**Figure 1-1**). There are three major components that make up the project area. These are the NGS and associated facilities, the proposed KMC, and the Western and Southern Transmission Systems (WTS and STS, respectively).

NGS is an existing 2,250-megawatt (MW) coal-fired power plant located on leased Navajo Nation Tribal Trust Lands about 5 miles east of Page, Arizona. Construction of the facility began in 1969 and power production started in 1973. NGS provides baseload power to over 1 million customers in Arizona, California, and Nevada. NGS also provides over 90 percent of the power used by the Central Arizona Project (CAP), a federal project that delivers approximately 1.5 million acre-feet annually of Colorado River water from a diversion point in Lake Havasu near Parker, Arizona, to central Arizona. Colorado River water delivered via the CAP serves tribal, agricultural, municipal, and industrial water users in Maricopa, Pinal, and Pima counties, Arizona.



Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 1-1

General Project Location

7/20/2016

The Salt River Project Agricultural Improvement and Power District (SRP) is the operating agent of the NGS and holds a 21.7 percent ownership interest in the NGS on its own behalf. SRP also purchased the 21.2 percent interest in NGS, through 2019, that was formerly held by the Los Angeles Department of Water and Power.[1] Pursuant to an agreement with the U.S., SRP also holds a 24.3 percent interest in the NGS for the use and benefit of the U.S., which is used to operate the CAP. SRP, Arizona Public Service, NV Energy, and Tucson Electric Power Company are NGS Co-tenants. Altogether, with the U.S., the five entities collectively are referred to as the "NGS Participants." The current NGS Participants and interest percentages are displayed in **Figure 1-2**. The NGS includes three 750-MW electric generating units that produce up to 2,250 MW of net output. The U.S. share of NGS power at full output is 546.7 (547) MW.

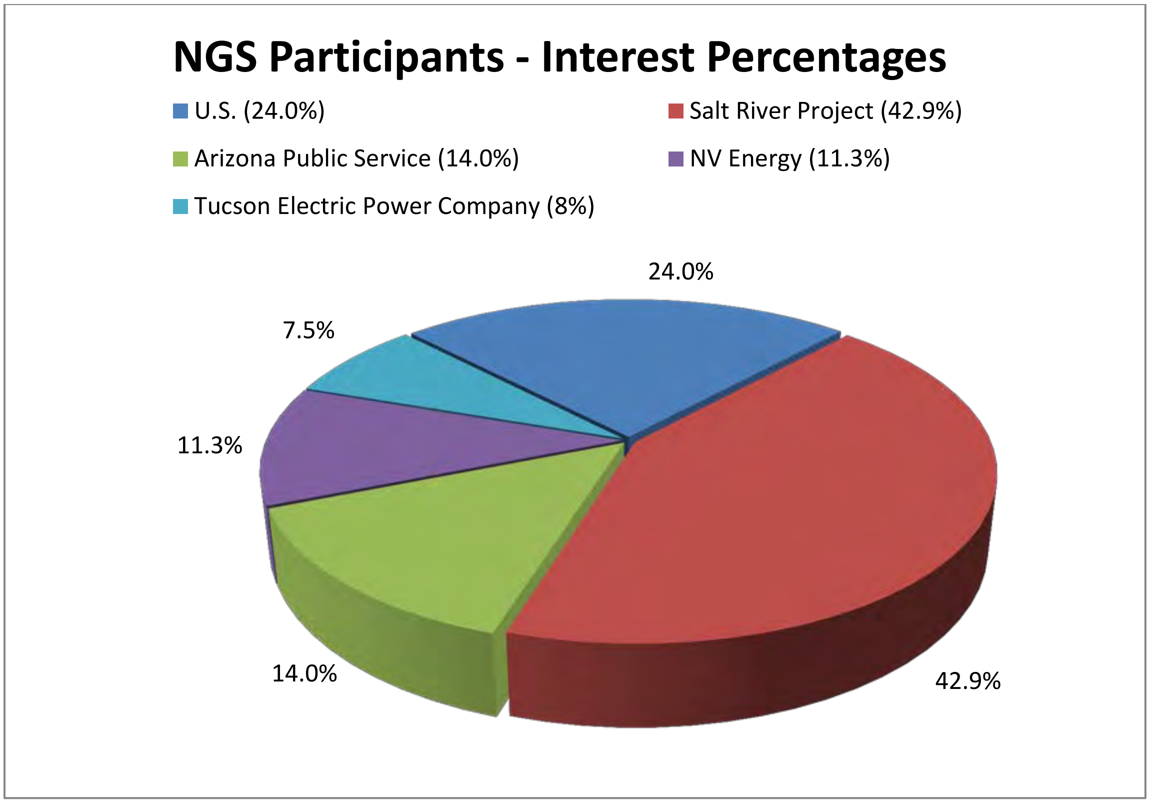
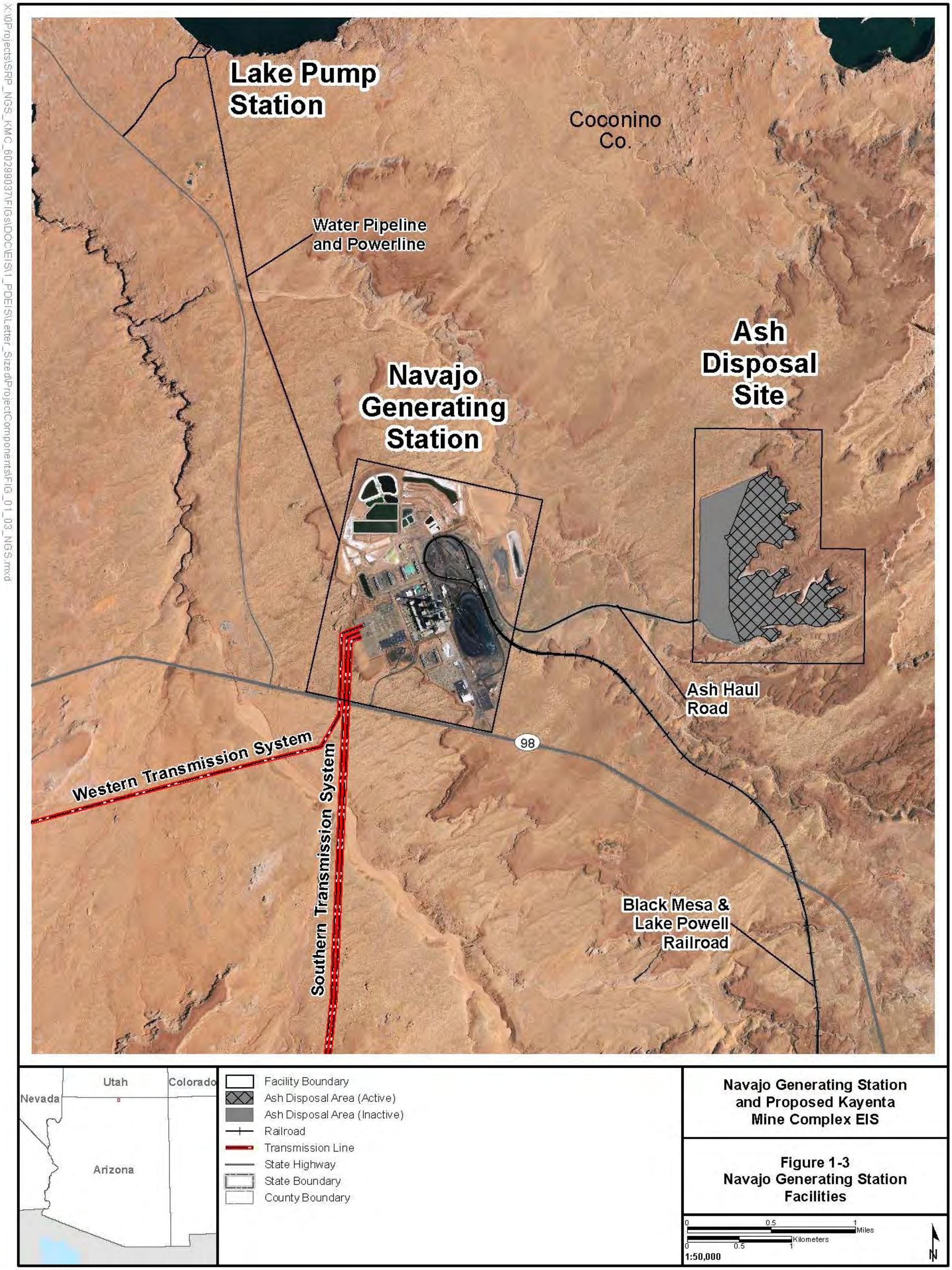


Figure 1-2 NGS Participants' Interest Percentages

Facilities associated with the NGS include a water supply system from Lake Powell; coal-fired boilers; steam turbine generators; water treatment facilities; air pollution control systems; waste management facilities including landfills; transformers; switchyards; substations; roads; communication sites; and administration, operation, maintenance, and warehouse facilities. There also is the approximately 78-mile electric Black Mesa & Lake Powell (BM&LP) Railroad plus a 2-mile railroad turn-around loop and coal-handling facilities at the railroad-terminus at the plant. The features of NGS and its associated facilities are described in Section 1.7.1. An overview of NGS facilities is shown in **Figure 1-3**.

[1] On July 1, 2016, Los Angeles Department of Water and Power executed an asset purchase agreement with SRP wherein SRP acquired Los Angeles Department of Water and Power's share of NGS generation through 2019. Los Angeles Department of Water and Power intends to continue to participate in the NGS transmission system and is referred to in this document as an NGS Transmission-Only Participant. See Section 1.8.3 for additional information.



Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 1-3
Navajo Generating Station Facilities

The fuel supply for the three generating units is low sulfur bituminous coal transported by the BM&LP Railroad to NGS from the Kayenta Mine. Kayenta Mine is owned and operated by the Peabody Energy subsidiary, Peabody Western Coal Company (PWCC). On April 13, 2016, Peabody Energy and the majority of its U.S. subsidiaries, including PWCC, voluntarily filed petitions to reorganize under Chapter 11 of the U.S. Bankruptcy Code in the U.S. Bankruptcy Court for the Eastern District of Missouri. The bankruptcy court filings state that Peabody and its subsidiaries expect to emerge from bankruptcy in or about April 2017. During the bankruptcy, mining and reclamation activities are continuing and are expected to continue in a business-as-usual fashion at the Kayenta Mine. During and after the bankruptcy, PWCC and any reorganized entity, must still comply with all applicable laws, including federal, state, and Tribal environmental laws, as well as the terms and conditions of the mine leases.

The Kayenta Mine is located about 78 miles southeast of NGS on Navajo Nation and Hopi Tribal Trust Lands near Kayenta, Arizona (**Figure 1-1**).The Kayenta Mine is the sole commercial supplier of coal used by the NGS, and the NGS is the sole commercial customer of coal produced at the Kayenta Mine.

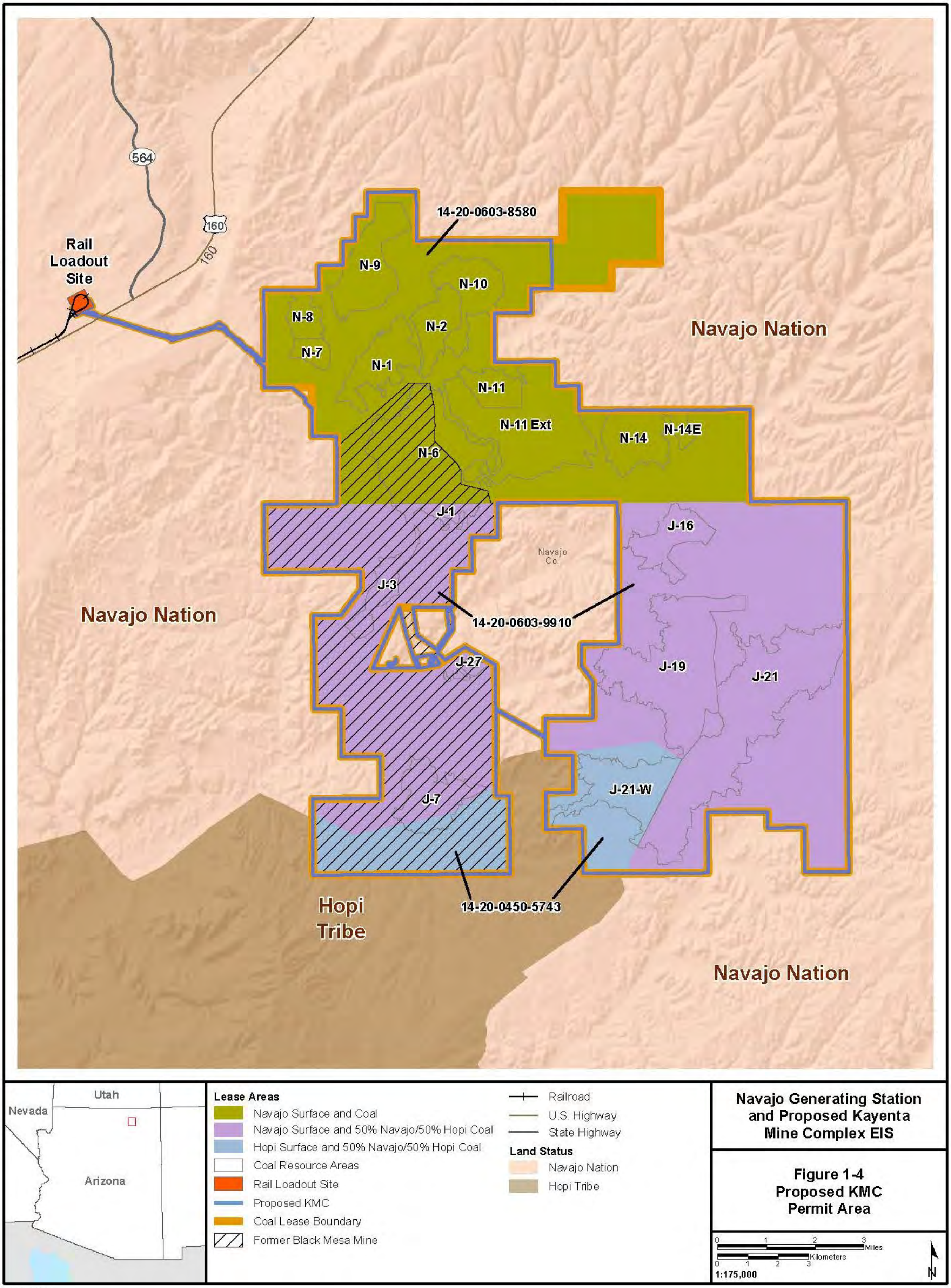
The entire mining leasehold is composed of contiguous mining leases and several surface rights-of-way (ROWs) and easements granted to PWCC from the Navajo Nation and Hopi Tribe (**Figure 1-4**). The leases are as follows:

1. Navajo Mining Lease Number 14-20-0603-8580: Surface and mineral interest for 24,858 acres.
2. Joint Use Navajo Mining Lease Number 14-20-0603-9910: Joint mineral ownership lease area for 40,000 acres, of which the Navajo Nation holds the surface interests for 33,863 acres.
3. Joint Use Hopi Mining Lease Number 14-20-0450-5743: Joint mineral ownership lease area for 40,000 acres, of which the Hopi Tribe holds the surface interest for 6,137 acres.

In what was formerly designated the “Joint Use Area” (former Joint Use Area), the Hopi Tribe and Navajo Nation have joint and equal interest in the minerals that underlie the area; however, the surface has been partitioned and is within the exclusive jurisdiction of the tribe to which the surface is partitioned. No new federal action is proposed to be taken with respect to these three leases, and none are needed as a result of the Proposed Action; therefore, these leases are not the subject of this EIS.

Pursuant to Public Law 95-87, the Surface Mining Control and Reclamation Act of 1977 (SMCRA), PWCC operated the entire mining leasehold as two separate surface mining operations—the former Black Mesa Mine and the Kayenta Mine—under the initial and permanent regulatory programs, respectively. The former Black Mesa Mine supplied commercial coal exclusively to the Mohave Generating Station, located near Laughlin, Nevada, until the Mohave Generating Station shut down in December 2005.[2] No coal production has occurred from the former Black Mesa Mine since 2005, and none is currently planned or permitted; however, mine reclamation activities have continued at the former Black Mesa Mine.

[2] The Mohave Generating Station has since been completely dismantled, and all structures have been removed from the site except for its switchyard, transmission lines, and pumping station.



Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 1-4
Proposed KMC
Permit Area

7/20/2016

The Kayenta Mine supplies coal to the NGS at a current production rate of about 8 million tons per year. The Kayenta mining operation uses support facilities also used by the former Black Mesa Mine and reclamation operation. This is consistent with PWCC's approved permit application package under the SMCRA (PWCC 2012 et seq.). At the current production rate, mining coal for the NGS at the Kayenta Mine could continue through 2026 under its existing SMCRA Permit and Life-of-Mine Plan.

Power is transmitted from NGS to substations near Las Vegas, Nevada, and Phoenix, Arizona, via two transmission systems known as the WTS and STS (**Figure 1-1**). These two transmission systems are operated as part of the NGS Project to provide safe and reliable power to the NGS Participants' customers, including the CAP. Both the WTS and STS are integrated in the country's western electrical grid and are used for energy transmission other than the power being generated at NGS.

The WTS consists of a 500-kilovolt (kV) transmission line that begins at NGS and heads west across northern Arizona, with two small segments crossing into Utah. The transmission line then enters Nevada and continues in a southwesterly direction toward Las Vegas, ending at the McCullough substation just outside Boulder City, Nevada. The WTS line is 275 miles long. The NGS Participants that utilize the WTS include the NV Energy, and the U.S. Los Angeles Department of Water and Power is the administrator and NV Energy is responsible for on-the-ground operation and maintenance. The STS consists of two parallel, 500-kV transmission lines, both of which begin at NGS and head south, ending at the Westwing substation, in Peoria, Arizona. The STS lines are 256 miles long and are located entirely in Arizona. All five NGS Participants, as well as Los Angeles Department of Water and Power, have an interest in all or a portion of the STS, which is operated by Arizona Public Service.

Altogether there are 8 substations/switchyards, besides the one located within the NGS plant site, and 19 communication sites that support the two transmission systems, railroad, and NGS operations.

The Proposed Action includes, but is not limited to, the following federal agency actions that would allow NGS to operate from December 23, 2019 through December 22, 2044, plus sufficient time for decommissioning of the plant and its associated facilities, and reclamation of the proposed KMC (for purposes of the EIS this period is referred to as 2020 through 2044 plus decommissioning):

1) approval and execution of an NGS plant lease amendment (or a lease agreement among the Navajo Nation and the continuing NGS Participants only, under substantively the same terms as the 1969 lease and the proposed amendment);
2) approval of new, renewed, or amended grants of ROW and easements for the NGS plant site and related facilities, including the BM&LP Railroad and the water intake facility at Lake Powell;
3) approval of new, renewed or amended ROWs and easements that support the two transmission systems used to deliver the electricity, including nine substations, and 19 communication sites;
4) negotiation and execution of a water service contract renewal for delivery of Upper Basin Colorado River water to support NGS operations through 2044 plus decommissioning;
5) approval of a permit revision application that would update the Life-of-Mine Plan and adjust the permit boundary to allow continued coal mining operations at the Kayenta Mine for the same time period, and realign Navajo Route 41; and
6) approval by the U.S., acting through Reclamation, of all contracts, easements, ROWs and other legal arrangements needed to extend the operation of NGS through the end of 2044.[3]

[3] In addition to the NGS plant site lease, the existing operation of NGS, proposed KMC, and their associated facilities are subject to complex legal arrangements and federal approvals. These arrangements, as well as any proposed extensions, modifications, or new arrangements anticipated by the Proposed Action, are described in the synopsis of NGS and KMC documents (**Appendix 1A**).

1.2 Project Location

As indicated in Section 1.1, portions of the project area are located in Arizona, Utah, and Nevada. The NGS plant site, its associated facilities, and the proposed KMC are located in the central part of northern Arizona. The WTS crosses lands in Arizona, Utah, and Nevada, while the STS extends south from the NGS to the Phoenix metropolitan area in central Arizona. The mining permit area is located on Navajo and Hopi Tribal Trust Lands. The NGS plant and associated facilities, with the exception of a small portion of the Colorado River water intake facility at Lake Powell, are located on Navajo Tribal Trust Lands. Portions of the WTS and STS also are located on Navajo Tribal Trust Lands. The remainder of the NGS-KMC Project area, consisting of the remaining portions of the WTS and STS, is located on a mix of public and private land.

Other areas impacted by the Proposed Action are discussed under the appropriate “action area” descriptions in Chapter 3.0. For example, impacts on the three-county CAP service area are addressed in Socioeconomic Resources, Section 3.18. This is because the U.S.’ share of NGS power is used to operate the pumps that deliver water to the CAP service area. Decisions made regarding the Proposed Action may affect those using CAP water, since the cost of energy to operate the CAP pumps is a major component of the cost of CAP water to its users.

1.3 Project Background

The initial apportionment of water from the Colorado River was determined as part of the Colorado River Compact of 1922, which divided the Colorado River system into two sub-basins, the Upper Basin and the Lower Basin. The Colorado River Compact of 1922 also divided the seven Colorado River Basin states into the Upper Division and the Lower Division states,[4] and apportioned to each division, in perpetuity, the exclusive beneficial consumptive use of 7.5 million acre-feet annually. Lower Division state apportionments were established by Congress in the 1928 Boulder Canyon Project Act (Public Law 70-642, 45 Statute 1057), and later confirmed by the 1963 U.S. Supreme Court opinion in *Arizona v. California* (373 U.S. 546) and subsequent Consolidated Decree (547 U.S. 150). These annual apportionments are: Arizona, 2.8 million acre-feet; California, 4.4 million acre-feet; and Nevada, 0.3 million acre-feet. Arizona also holds an Upper Basin apportionment of 50,000 acre-feet of Colorado River annually.

The 1968 Colorado River Basin Project Act (Public Law 90-537, 82 Statute 885) authorized the construction, operation, and maintenance of the CAP, which facilitates the full utilization of Arizona’s Lower Division Colorado River apportionment. It also provided the legal authority for the federal government, through the Secretary of the Interior, to enter into agreements to participate in the “Navajo Project,”[5] which generates the power and energy[6] used to operate the CAP pump stations. The Colorado River Basin Project Act states that the U.S.

> “…may enter into agreements with non-federal interests proposing to construct thermal generating power plants whereby the United States shall acquire the right to such portions of their capacity, including delivery of power and energy over appurtenant

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[4] The Upper Division states are Colorado, New Mexico, Utah, and Wyoming; the Lower Division states are Arizona, California, and Nevada.

[5] The original NGS-Kayenta Mine Project was named the “Navajo Project”; however, due to potential confusion with a recent OSMRE project called the Navajo Mine Energy Project, this document uses the term NGS Project when referring to the original “Navajo Project.”

[6] For purposes of this document, power means electrical power, which is the rate at which electrical energy is transferred, as measured in watts, kilowatts, MW; energy means electrical energy, which is the amount of power used over time, generally measured in kilowatt-hours, or MW-hours (MWh).

transmission facilities to mutually agreed upon delivery points, as…required in connection with the operation of the Central Arizona Project."

The agreements authorized by the Colorado River Basin Project Act covered construction and operation of four major features of the NGS Project: 1) the NGS plant and associated facilities including the BM&LP Railroad that delivers coal from the Kayenta Mine to the plant site; 2) the coal supply from the Kayenta Mine, described in Section 1.7.2.1; 3) the water supply for NGS and the water intake structures (located on federal land administered by the National Park Service) used to transport Upper Basin Colorado River water for use at NGS described in Section 1.7.1.4); and 4) WTS and STS and communication sites, described in Section 1.7.3. These agreements are summarized below and described in greater detail in **Appendix 1A**.

The "Navajo Project Indenture of Lease for Navajo Units 1, 2, and 3" (1969 Lease [also referred to in this document as "Indenture of Lease for Units 1, 2, and 3"]) was dated on September 29, 1969, between the Navajo Tribe of Indians (now the Navajo Nation, which is used in the remainder of the EIS) and the NGS Co-tenants; this executed lease was approved by the Secretary of the Interior. The 1969 Lease encumbered Navajo Tribal Trust Lands used for the "Plant Site, Rail Loading Site, Ash Disposal Area, Auxiliary and Related Rights." The 1969 Lease was entered into for the plant construction "…together with transmission facilities interconnecting the electric system of Lessees and furnishing a means of transmitting power and energy for the U.S... Central Arizona Project pumping power requirements…" The 1969 Lease expires December 22, 2019. The associated BIA 323 Grant of ROW[7] issued to the NGS Co-tenants for the NGS plant site expires at the end of 2019, while the initial term of another 323 Grant for the BM&LP Railroad expires in 2021. The 1969 Lease provides an option and/or right to extend the lease for an additional 25 years, until December 22, 2044, plus decommissioning. Lease Amendment No. 1 to the 1969 Lease (Lease Amendment No.1) provides the Navajo Nation's consent to the extension of the NGS lease through 2044, plus decommissioning, and provides the Navajo Nation's consent to the issuance, renewal, and/or extension of the 323 Grants of ROWs for the plant site, railroad, transmission systems and communication sites within the Navajo Nation, as described below. The Navajo Nation Council approved the Lease Amendment No. 1 on July 17, 2013, which authorized the President of the Navajo Nation to sign the Lease Amendment No. 1. The Navajo Nation President signed Lease Amendment No. 1 on July 30, 2013, per Navajo Nation Council Resolution CJY-40-13.[8]

The WTS and STS also are supported by 323 Grants on the Navajo Reservation. Off the Navajo Reservation, these systems are supported by grants of ROW and easements issued by other federal agencies, state agencies, municipalities, and private landowners.

The Colorado River Basin Project Act also authorized the sale of surplus NGS power and energy at market rates to provide a source of revenue for the Lower Colorado River Basin Development Fund (Development Fund), which is used to assist in repayment of the CAP construction costs, stating:

---

[7] Request for the BIA to grant a ROW under the terms and provisions of the Act of February 5, 1948 (Title 25 United States Code [USC] Sections 323-328) and Departmental Regulations at 25 CFR Part 169.

[8] Depending on the composition of plant ownership on December 23, 2019, the provisions of the 1969 lease and Lease Amendment No. 1 may be merged into a single, new lease among the Navajo Nation and the continuing NGS Participants only. Should this occur, authorization of the new lease, if required, would be sought and obtained from the Navajo Nation.

> "When not required for the Central Arizona Project, the power and energy acquired by such agreements may be disposed of intermittently by the Secretary…so as to produce the greatest practicable amount of power and energy that can be sold at firm power and energy rates."

Subsequent authorization was included in the Arizona Water Settlements Act of 2004 (Public Law 108-451, 118 Statute 3478) to allow the Development Fund to be used for the payment of fixed operation, maintenance, and replacement charges associated with the delivery of CAP water to Arizona Native American tribes and other statutory purposes. More information on how the Development Fund is managed is provided in Socioeconomic Resources, Section 3.18.3.3.

The Co-Tenancy Agreement for NGS, dated March 23, 1976 (Co-Tenancy Agreement) among the NGS Participants establishes the terms and conditions relating to the NGS Participants' interests in NGS and its related facilities, and establishes certain rights and obligations of the parties. The Co-Tenancy Agreement controls U.S. participation in the decisions that affect the federal interest at NGS. As provided in the Co-Tenancy Agreement, SRP must obtain the prior written consent of the U.S. for actions that would affect the interest in NGS held by SRP for the use and benefit of the U.S., including actions to extend NGS operations after 2019.

The Secretary has delegated the authority to carry out the U.S.-related aspects of the NGS contracts to Reclamation. Reclamation also serves as the contractor for the existing Water Service Contract which supplies Upper Basin Colorado River water to the NGS. Pursuant to the Colorado River Storage Project Act (Public Law 203-485, 70 Statute 105) and other federal reclamation laws, Reclamation must negotiate and approve the terms of a Water Service Contract renewal through 2044 as part of the Proposed Action.

With respect to the fuel supply for NGS from the Kayenta Mine, Sentry Royalty Company entered into a lease with the Navajo Nation in 1964 to lease a tract of land containing 24,858 acres for the purpose of surface coal mining (Mining Contract No. 14-20-0603-8580). In 1966, Sentry Royalty Company entered into leases with the Navajo Nation (Mining Contract No. 14-20-0603-9910) and Hopi Tribe (Mining Contract No. 14-20-0450-5743) containing 40,000 acres. These leases allowed extraction of 400 million tons of coal. The three leases were assigned to and operated by Peabody Coal Company in 1968 and, in turn, were reassigned to PWCC (collectively referred to as PWCC), in 1994. In 1987, these leases were amended to add an additional 270 million tons of coal. The 64,858-acre leased area provides for maximum coal production of 670 million tons of coal.

1.4 Prior Relevant National Environmental Policy Act Compliance

1.4.1 Navajo Generating Station and Related Facilities

Construction of NGS was initiated prior to passage of NEPA in 1969, and before the CEQ issued its "Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act" on December 31, 1970. Guidelines for federal agencies issued pursuant to NEPA by the CEQ on April 23, 1971, established NEPA compliance requirements for existing programs and projects already underway, "where it is not practicable to reassess the basic course of action…." (CEQ 1971). Consistent with these requirements, Reclamation prepared an EIS on the initial NGS Project to assess further additional major actions to minimize adverse environmental consequences, and to take into account the "environmental consequences of actions not fully evaluated at the outset of the project or program…." (Reclamation 1972b).

The 1972 NGS Project EIS summarized pre-NEPA federal actions undertaken prior to January 1, 1970. These included the following: the Secretary of the Interior's approval of the 1969 Lease between the NGS Co-tenants and the Navajo Nation; the Secretary of the Interior's grant of ROW and easements to the NGS Co-tenants; the Secretary of the Interior's execution of a contract between the U.S. and SRP for NGS water service from Lake Powell; execution of the Participation Agreement among the NGS Co-tenants and the U.S., through which the parties agreed to proceed with construction and operation of the NGS Project; and execution of interim sales contracts between the U.S. and each of the NGS Co-tenants, providing for the sale of the U.S.' share of NGS power and energy to the Co-tenants prior to CAP operation.

The 1972 NGS Project EIS also evaluated major federal actions remaining to be implemented (Reclamation 1972b). The 1972 EIS described and assessed the environmental consequences of actions planned but not yet initiated at the time the EIS was prepared. The planned actions included the construction and operation of the following features of the project:

- Navajo Generating Station;
- BM&LP Railroad;
- Black Mesa Coal Mining Operation (which included both the former Black Mesa Mine and the Kayenta Mine);
- WTS; and
- STS.

For the WTS and STS, the 1972 EIS summarized two environmental statements that had been prepared to document the evaluation and selection of the route for each system. The environmental statement prepared by the U.S. Department of Agriculture's Forest Service, regarding the proposed STS, initially considered six alternate routes. The environmental statement prepared by the Bureau of Land Management (BLM) regarding the WTS, initially considered four routes.

Reclamation prepared another EIS in 1972 covering the construction of the CAP system, consisting of the following: one concrete and three earth-fill dams; four aqueducts, including tunnels and siphons; one major and several smaller pumping plants; and transmission facilities to provide power for the pumping plants (Reclamation 1972a). There have been additional subsequent NEPA documents covering actions related to the CAP, both for construction and operation of facilities, and issuance of contracts for allocations of CAP water.

1.4.2 Navajo Generating Station Water Intake Structure Project

The water intake structures deliver Colorado River water from Lake Powell for use in operations at the NGS. Due to drought conditions beginning in 2000, the lake elevation had dropped to 3,557 feet above mean sea level by 2004, which was only 70 feet higher than the minimum water elevation necessary for the NGS water intake pumps to remain operational. Deeper intake structures were needed to ensure that cooling water would be available for the continued operation of the NGS if drought conditions persisted and lake levels continued to fall. Construction of the new intake structures required a new easement within the boundary of the Glen Canyon National Recreation Area; therefore, National Park Service was the lead federal agency for complying with NEPA for this action. In March 2005, the National Park Service prepared an environmental assessment covering the construction and operation of new, deeper, water intake structures and subsequently issued a Finding of No Significant Impact (National Park Service 2005). The new intake structures were completed in 2009, and are approximately 120 feet lower than the original structures.

1.4.3 Navajo Generating Station Water Service Contract

A contract for water service from Lake Powell for NGS, Reclamation Contract No. 14-06-300-5033, dated January 17, 1969, was executed between the U.S., acting through the Secretary of the Interior and represented by Reclamation (Upper Colorado Regional Office) and SRP, as operator of the NGS. It provided that SRP could divert up to 40,000 acre-feet per year of Colorado River water from Lake

Powell, and consumptively use up to 34,100 acre-feet per year, for the operation of the NGS. The Navajo Tribal Council enacted two resolutions approving the allocation of 34,100 acre-feet per year from Arizona's 50,000 acre-feet per year share of the Upper Colorado River Basin, Resolution CD 108-68, dated December 11, 1968, and Resolution CJW-69, dated June 3, 1969. The 1969 Water Service Contract (Contract) had an initial 40-year term with a right to renew the Contract for 20 additional years under the same terms except for renegotiation of the water charge. This Contract was renewed on July 16, 2012. The Contract will expire on July 6, 2032 (for additional information see **Appendix 1A**).

1.4.4 Black Mesa-Kayenta Mine

As a result of promulgation of the Indian Lands Program under the SMCRA (30 CFR Subchapter E) in 1984, OSMRE prepared an EIS for the "Proposed Permit Application, Black Mesa-Kayenta Mine, Navajo and Hopi Indian Reservations, Arizona" submitted by PWCC in 1985 under the permanent regulatory program.

OSMRE's final Mine EIS was issued in June 1990, and the Secretary of the Interior approved the renegotiated leases with the Hopi Tribe and Navajo Nation (OSMRE 1990). OSMRE issued a permanent program permit, AZ-0001C, for the Kayenta mining operation in 1990 and has subsequently renewed the permit four times.[9] The decision to permanently permit the Black Mesa mining operations was administratively delayed at the direction of the Secretary of the Interior, pending resolution of concerns expressed by the Hopi Tribe and the Navajo Nation regarding use of Navajo Aquifer (N-Aquifer) water for coal-slurry purposes related to the Mohave Generating Station. Black Mesa mining operations continued pursuant to the initial regulatory program (Holt 2010). The use of former Black Mesa support facilities at Kayenta Mine, discussed further in Section 1.7.2.2, continues to be subject to the initial regulatory program.

In February 2004, PWCC submitted a life-of-mine permit revision application proposing several revisions to improve and/or enhance the efficiency and cost-effectiveness of the Kayenta permit and Life-of-Mine Plan and to include Black Mesa mining operations in the permanent permit. OSMRE issued a Draft EIS on the Black Mesa Project in November 2006. After the shut-down of the Mohave Generating Station in December 2005, PWCC amended the application to update information and omit proposed permit revisions related to the Black Mesa mining operations supplying coal to the Mohave Generating Station. A final Black Mesa Project EIS was issued in November 2008 (OSMRE 2008). Included in the preferred alternative was a proposal to incorporate the former Black Mesa Mine shared facilities and remaining Black Mesa coal-resource areas into the permanent permit boundary. A Record of Decision was issued in December 2008. In January 2010, a U.S. Department of the Interior administrative law judge responsible for the administrative review of OSMRE's approval of PWCC's permit revision application ruled that the Final EIS did not satisfy NEPA and vacated OSMRE's Record of Decision (Holt 2010). In accordance with the vacated decision, OSMRE reversed the revisions to the permit, and the 2004 application for revision was abandoned.

OSMRE prepared an environmental assessment (OSMRE 2011) in response to PWCC's 5-year permit renewal application.[10] The application addressed continuation of ongoing Kayenta Mine surface coal mining and reclamation activities in coal resource areas N-9, J-19, and J-21 for the period July 2010 through July 2015. OSMRE issued a Finding of No Significant Impact and issued PWCC's renewed Permit AZ-0001E in January 2012.

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[9] When the permit is renewed an alphabetic designation is added to the permit to signify the current permit term. The current permit is AZ-0001E; when the 2015 renewal application is approved the permit will be designated AZ-0001F.

[10] SMCRA regulations grant a right of successive renewal within the approved boundaries of an existing mining permit so long as certain conditions are met. Title 30 CFR Part 773.19(d) and Title 30 CFR Part 774.15(a); Title 30 USC Section 1256(d)(1).

On February 26, 2015, PWCC submitted to OSMRE an application to renew Permit AZ-0001E, which would authorize continuation of ongoing Kayenta Mine surface coal mining and reclamation activities in coal resource areas N-9, J-19, and J-21 for the 5-year period July 2015 through July 2020. Agency action on the current permit renewal application is on administrative hold pending completion of NEPA reviews. For purposes of NEPA, the renewal application is independent of the project approvals for the Proposed Action in this EIS because the 5-year renewal application covers the period of 2015 through 2019 which is prior to the Proposed Action, and the renewal would occur with or without the Proposed Action.

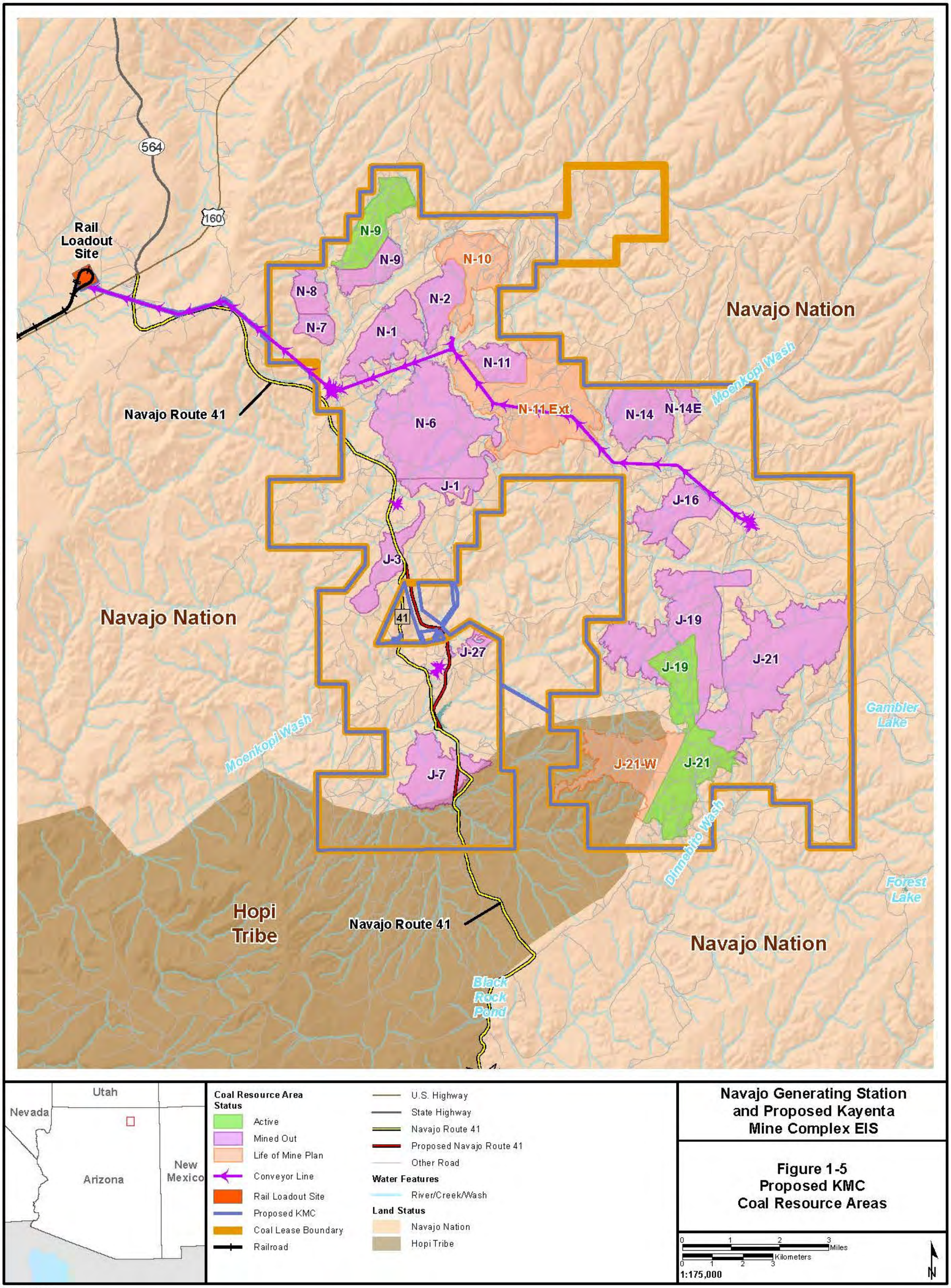
1.5 Background for the Federal Agencies' Purpose and Need

Subsequent to the Navajo Nation Council approval of Resolution CJY-40-13 on July 17, 2013, which recommended and approved Lease Amendment No. 1 to be signed by the Navajo Nation President, SRP, as the NGS operating agent, sent a letter to the Secretary of the Interior on July 20, 2012, requesting that the U.S. Department of the Interior initiate compliance under NEPA, the ESA, and other applicable federal environmental laws with respect to the federal actions necessary to enable operation of NGS and its associated facilities to continue beyond December 22, 2019 (SRP 2012).

As provided in the "Navajo Project Co-Tenancy Agreement" (for additional information, see **Appendix 1A**) among the NGS Participants, SRP must obtain the prior written consent of the U.S. (acting through Reclamation) for actions that would provide for the U.S.' continued participation in NGS after 2019. Reclamation's actions, therefore, include providing its consent to the Lease Amendment No. 1 (or a lease agreement among the Navajo Nation and the continuing Co-tenants of NGS only under substantively the same terms as the 1969 Lease and proposed Lease Amendment No. 1), the 323 Grants, an extended coal supply agreement, and the extension of any other arrangements needed for continuation of operations at NGS and the Kayenta Mine through 2044, and funding for these actions. Reclamation's actions also include the negotiation of the water service contract renewal through 2044, plus decommissioning, and issuance of a ROW for a portion of the WTS that crosses Reclamation land in Nevada.

Because NGS and much of its associated facilities, including segments of the WTS and STS, are located on Navajo Nation Tribal Trust Lands, the BIA has actions associated with the project, namely, the approval of the proposed NGS Lease Amendment No. 1 (or a lease agreement among the Navajo Nation and the continuing co-tenants of NGS only under substantively the same terms as the 1969 NGS Lease and proposed Lease Amendment No. 1) and issuance of new or amended 323 Grants, described in Section 1.3 and **Appendix 1A**. The lease of lands on the Navajo Reservation is provided for by 25 USC Section 415(a), with approval of the Secretary of the Interior, for "…business purposes, including the development or utilization of natural resources in connection with operations under such leases," for up to 99 years. In accordance with 25 USC Section 323 and 25 CFR Part 169, issuance of new or amended grants is sought through application to the BIA.

PWCC holds an active SMCRA Permit (PWCC 2012 et seq.) authorizing it to mine within the Kayenta Mine permit area. Sufficient coal reserves are authorized under the existing permit to continue mining through 2026 at current production rates. On March 5, 2014, the OSMRE deemed PWCC's significant permit revision application for the Proposed Action to be administratively complete (OSMRE 2014). PWCC is seeking to revise its SMCRA Permit and Life-of-Mine Plan for the proposed KMC to adjust and identify the timing and sequence of mining operations in certain coal resource areas through 2044 (**Figures 1-4** and **1-5**), and to relocate portions of the existing Navajo Route 41 (PWCC 2012 et seq.). Additionally, PWCC is proposing to incorporate the adjacent 18,857-acre former Black Mesa Mine area into the existing Kayenta Mine AZ- 0001E permit area, which matches the mining lease boundary of 14-20-0450-5743 and 14-20-0603-9910. Facilities on the Black Mesa Mine currently being used to support the Kayenta Mine operations would be permitted as permanent program lands and all other lands would remain under pre-law or initial program land jurisdiction (**Figures 1-4** and **1-5**); however, the proposed expansion of the boundary of



Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 1-5
Proposed KMC
Coal Resource Areas

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the existing Kayenta Mine AZ-0001E permit area would not authorize any future mining anywhere in the former Black Mesa Mine area. Incorporation of these mining support facilities and the lands previously used for the former Black Mesa mining operations into the existing Kayenta Mine AZ-0001E permit area, if approved, would create the proposed KMC. The coal slurry pipeline, and associated Black Mesa Pipeline Company facilities that previously connected the former Black Mesa Mine with the decommissioned Mohave Generating Station are not PWCC facilities and are not part of the proposed NGS-KMC Project.

In addition to the actions to be taken by BIA and OSMRE, other federal agencies must act on applications to re-issue expiring ROWs and easements for portions of the WTS and STS located on federal land outside the Navajo Reservation, and provide various approvals where applicable. See **Table 1-1** for a complete list of these actions and actions by other entities associated with the project.

Table 1-1 Preliminary List of Federal Actions for the NGS-KMC Project

Entity and Role in EIS	Approval Action – NGS and Associated Facilities, WTS, and STS	Approval Action – Proposed KMC
Federal Entities		
Reclamation Role: Lead federal agency for purposes of complying with the National Environmental Policy Act (NEPA), Section 7 of the Endangered Species Act (ESA), and Section 106 of the National Historic Preservation Act, Ensure adequate coordination with the key cooperating agencies, other cooperating agencies, and affected tribes as appropriate. Ensure EIS complies with the Council on Environmental Quality, U.S. Department of the Interior, and Reclamation NEPA requirements; review and approve project mitigation; ensure all information is adequate to issue a Record of Decision based on the Final EIS analysis. Conduct Government-to-Government consultations with affected tribes.	Approve or consent to contracts and other arrangements to extend the NGS Project operations through 2044, including but not limited to: • Amendment No. 1 to the Indenture of Lease between Navajo Nation and NGS Participants (or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1); • Land grants, easements, and ROWs; • Revisions to or new Co-Tenancy Agreement and other Navajo Project Agreements among the NGS Participants; and • Extension of the Coal Supply Agreement. Develop and approve terms of a renewal contract for water service from Lake Powell for operations through 2044 pursuant to Article 2 of the January 17, 1969, Water Service Contract; 1902 Reclamation Act (32 Statute 388) as amended; and 1956 Colorado River Storage Project Act Boulder Canyon (70 Statute 105), as amended. Issue a new license for the railroad crossing under the Glen Canyon Shiprock 230-kilovolt transmission line, Contract No. 14-06-400-5882 pursuant to the 1902 Reclamation Act (32 Statute 388), as amended. Issue new easement for a portion of the WTS pursuant to the 1902 Reclamation Act (32 Statute 388), as amended. Approve and provide funding in proportion	Approve coal supply agreement between PWCC and NGS Co-tenants.

Table 1-1 Preliminary List of Federal Actions for the NGS-KMC Project

Entity and Role in EIS	Approval Action – NGS and Associated Facilities, WTS, and STS	Approval Action – Proposed KMC
	to its Participant share in NGS of the actions required for the operation of NGS, WTS, and STS according to the project agreements and for eventual decommissioning.	
OSMRE – Western Region Role: Act as key cooperating agency per Memorandum of Understanding among Reclamation, OSMRE, BIA, SRP, and PWCC. Review EIS regarding compliance with OSMRE requirements; ensure all information is adequate to issue a Record of Decision based on the Final EIS analysis. Participate in government-to-government consultations.	None	Approve a permit revision for: • Changes in the proposed KMC Life-of-Mine Plan; • Relocation of a public road; and • Adjustment of a permit boundary pursuant to SMCRA to include existing support facilities (30 USC Section 1201 et seq.). Consult on potential impacts to cultural resources. Participate in ESA Section 7 consultation.
BIA – Navajo Region Role: Act as key cooperating agency per Memorandum of Understanding among Reclamation, OSMRE, BIA, SRP, and PWCC. Review EIS regarding compliance with BIA requirements; ensure all information is adequate to issue a Record of Decision based on the Final EIS analysis. Participate in government-to-government consultations.	Approve the NGS Project Lease Amendment No. 1 (or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1) pursuant to 25 USC Section 415(a) and 25 CFR Part 162. Approve renewed, amended, or new 323 Grants of ROW and easements for the NGS Project on Navajo Nation Indian Lands pursuant to 25 USC Section 323 and 25 CFR Part 169, including but not limited to: • Plant Site and associated facilities; • Railroad; • Coal Conveyor; • WTS; • STS; • Communication Sites; and • Moenkopi Switchyard. Approve actions by the Navajo Nation to take on an ownership interest in NGS pursuant to provisions contained in the Lease Amendment No.1 (or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1), should the Navajo Nation choose to do so. Consult on potential impacts to cultural resources.	Approve realignment of Navajo Route 41 pursuant to 30 CFR Part 761.14(b). Renew or issue new grants of ROW and easements for the NGS-KMC Project on tribal lands.

Table 1-1 Preliminary List of Federal Actions for the NGS-KMC Project

Entity and Role in EIS	Approval Action – NGS and Associated Facilities, WTS, and STS	Approval Action – Proposed KMC
	Participate in ESA Section 7 consultation.	
BIA – Western Region Role: Act as cooperating agency per Memorandum of Understanding between Reclamation and BIA – Western Region. Participate in government-to-government consultations.	Approve or disapprove Pipe Spring communication site 323 Grant pursuant to 25 USC Section 323 and 25 CFR Part 169. Consult on potential impacts to cultural resources	
BIA Western Region – Hopi Agency Role: Review EIS regarding compliance with BIA requirements; ensure all information is adequate to issue a Record of Decision based on the Final EIS analysis.	None	Approve realignment of Navajo Route 41 pursuant to 30 CFR Part 761.14(b).
Bureau of Land Management (BLM) Role: Act as cooperating agency per Memorandum of Understanding between Reclamation and BLM.	Issue new Federal Land Policy and Management Act ROW grants for the STS and WTS across jurisdictional public lands in Arizona, Utah, and Nevada pursuant to Title V. Ensure use is administered consistent with Public Law 96-491 for segment through Moapa Reservation. Consult on potential impacts to cultural resources. Participate in ESA Section 7 consultation.	Approve changes to the proposed KMC Resource Recovery and Protection Plan (mining plan) pursuant to 25 CFR Part 216; 43 CFR Part 3480.
U.S. Army Corps of Engineers Role: Review the EIS for compliance with Clean Water Act regulations, if applicable.	None	As applicable, approve Section 404 permit modifications and a revision for the proposed KMC pursuant to the Clean Water Act 33 USC Section 1342; 33 CFR Parts 320, 323, 325.
U.S. Fish and Wildlife Service Role: Act as cooperating agency per Memorandum of Understanding between Reclamation and U.S. Fish and Wildlife Service.	As applicable, prepare and issue a Biological Opinion, pursuant to Section 7 of the ESA (16 USC Section 1531 et seq.). Ensure compliance with the Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act.	As applicable, prepare and issue a Biological Opinion, pursuant to Section 7 of the ESA (16 USC Section 1531 et seq.). Ensure compliance with the Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act.

Table 1-1 Preliminary List of Federal Actions for the NGS-KMC Project

Entity and Role in EIS	Approval Action – NGS and Associated Facilities, WTS, and STS	Approval Action – Proposed KMC
National Park Service Role: Act as cooperating agency per Memorandum of Understanding between Reclamation and National Park Service.	Renew or issue a new ROW permit to cover a portion of the underground water intake (tunnel) system that supplies water to NGS. The renewed or newly issued permit would replace ROW Permit No. RW GLCA-06-002, granted pursuant to 16 USC Section 79 and expiring in 2032, to cover the period until 2044. Renew a ROW for a portion of the WTS on the Glen Canyon National Recreational Area pursuant to 16 USC Section 5 and 36 CFR Part 14. Consult on potential impacts to cultural resources. Participate in ESA Section 7 consultation.	None
U.S. Environmental Protection Agency (USEPA) Role: Act as cooperating agency per letter dated May 28, 2014. Review EIS for compliance with applicable federal environmental regulations.	USEPA has delegated the Clean Air Action's Title V operating permit program under 40 CFR Part 71 to the Navajo Nation Environmental Protection Agency (NNEPA). NNEPA issued the current Part 71 permit for the Kayenta Mine, and PWCC has submitted a renewal application to NNEPA. Final approval of Clean Air Act Title V, 40 CFR Part 71, operating permit renewal currently is pending with NNEPA. Action on this permit renewal is anticipated to occur prior to 2020.	As applicable, approve National Pollution Discharge Elimination System permit modifications and a revision for the proposed KMC pursuant to the Clean Water Act (33 USC Section 1342); 40 CFR Part 124.9. If needed, approve Nationwide Stormwater Discharge Permit. USEPA has delegated the Clean Air Act's Title V operating permit program under 40 CFR Part 71 to the NNEPA. NNEPA issued the current Part 71 permit for the Kayenta Mine, and PWCC has submitted a renewal application to NNEPA.
U.S. Forest Service Role: Act as cooperating agency per Memorandum of Understanding between Reclamation and U.S. Forest Service.	Renew ROWs across the Kaibab and Prescott National Forests in Arizona originally granted pursuant to the Act of March 4, 1911 (36 Statute 1253, as amended by Public Law 307, 66 Statute 95). Consult on potential impacts to cultural resources.	None

Table 1-1 Preliminary List of Federal Actions for the NGS-KMC Project

Entity and Role in EIS	Approval Action – NGS and Associated Facilities, WTS, and STS	Approval Action – Proposed KMC
Non-federal Entities		
Navajo Nation Role: Act as cooperating agency per Memorandum of Understanding between Reclamation and the Navajo Nation. Participate in government-to-government consultations.	Review and approve the Clean Air Act Title V, 40 CFR Part 71, operating permit renewal application. The Navajo Nation will periodically (every 5 years) review and issue the permit. Government-to-government consultation with Reclamation on Section 7 of the ESA and special status species. Decide whether to execute the option to take on an ownership interest in NGS pursuant to provisions contained in the Lease Amendment No. 1. If needed, and as an alternative to Lease Amendment No. 1, approval of a new lease agreement among the Navajo Nation and the continuing NGS owners having similar terms as Lease Amendment No. 1. Consult on potential impacts to cultural resources.	Consult on potential impacts to cultural resources. Government-to-government consultation on Section 7 of the ESA and Special Status Species. Consult by performing a technical review of the Life-of-Mine application. Approve or disapprove Clean Water Act Section 401 water quality certifications, if needed. On behalf of USEPA, issue renewal of KMC's federal Title V operating permit, if needed.
Hopi Tribe Role: Review the EIS and provide technical information. Participate in government-to-government consultations.	Consult on potential impacts to cultural resources.	Consult on potential impacts to cultural resources. Government-to-government consultation on Section 7 of the ESA and Special Status Species. Consult by performing a technical review of the Life-of-Mine application. Approve or disapprove Clean Water Act Section 401 water quality certifications, if needed.
Gila River Indian Community Role: Act as cooperating agency per Memorandum of Understanding between Reclamation and Gila River Indian Community.	None	None
Pueblo of Zuni Role: Review the EIS and provide technical information. Participate in government-to-government consultations.	Consult on potential impacts to cultural resources.	Consult on potential impacts to cultural resources. Government-to-government consultation on Section 7 of the ESA and Special Status Species.

Table 1-1 Preliminary List of Federal Actions for the NGS-KMC Project

Entity and Role in EIS	Approval Action – NGS and Associated Facilities, WTS, and STS	Approval Action – Proposed KMC
Central Arizona Water Conservation District Role: Act as cooperating agency per Memorandum of Understanding between Reclamation and the Central Arizona Water Conservation District.	None	None
Arizona Game and Fish Department Role: Act as cooperating agency per Memorandum of Understanding between Reclamation and the Arizona Game and Fish Department.	None	None

1.5.1 Federal Agencies' Purpose and Need

In the initial stages of this EIS, the Deputy Secretary of the Interior indicated Reclamation would be the lead federal agency for the environmental compliance effort, including preparation of this EIS for U.S. Department of the Interior (U.S. Department of the Interior 2012). Due to the substantial jurisdictional responsibilities of both OSMRE's Western Region and BIA's Navajo Region, these two agencies have been defined as key cooperating agencies. The agencies have worked very closely with Reclamation staff in the preparation of the EIS and on associated environmental regulatory requirements.

As an NGS Participant, Reclamation needs to respond to the impending expiration of the initial term of the 1969 Lease, grants of ROW and easements, and other agreements needed for the continued operation of NGS. **Table 1-1** lists a summary of arrangements for which Reclamation's consent or approval is required; **Appendix 1A** provides a more detailed description of these arrangements. Reclamation's purpose for the Proposed Action is to secure, after 2019, a continuously available and reliable source of power and energy to operate the CAP pumps, which would be competitively priced with NGS and could be sold as surplus power to generate revenues for deposit to the Development Fund, and to satisfy the purposes of the Arizona Water Settlements Act.[11] This purpose and need statement was revised from the statement in the Notice of Intent published in the Federal Register on

[11] Development Fund revenues are used to assist in repayment of CAP construction costs, and for the payment of fixed operation, maintenance, and replacement charges associated with the delivery of CAP water to Arizona Native American tribes and other statutory purposes.

May 16, 2014 (Federal Register, Volume 79, No. 95) announcing Reclamation's intent to prepare an EIS for the NGS-KMC Project. The refinement to include the need for a source of power and energy that would be competitively priced with NGS, as part of the purpose and need, was made as a result of comments received during the scoping process.

OSMRE is responsible for carrying out the requirements of SMCRA in cooperation with states and tribes. As the regulatory authority on Indian Lands, OSMRE (Western Region) is responsible for ensuring that the operation of the proposed KMC permit area would be in accordance with all SMCRA requirements, including all applicable environmental performance and reclamation standards. Accordingly, OSMRE needs to respond to PWCC's SMCRA Kayenta Mine permit revision application and proposed Life-of-Mine Plan and determine whether to approve, approve with special conditions, or disapprove the application, in accordance with the requirements of SMCRA. OSMRE's purpose for the Proposed Action is to implement the environmental protections, reclamation standards, and other permitting requirements under SMCRA, while balancing the U.S.' need for continued domestic coal production with protection of the environment (see 30 USC Section 1202).

BIA must decide, consistent with the requirements of 25 USC Part 415(a) and 25 CFR Part 169, and subject to the consent of the Navajo Nation, whether or not to approve: 1) the NGS Lease Amendment No. 1 or a lease agreement among the Navajo Nation and the continuing NGS Co-tenants only under substantively the same terms as the 1969 Lease and proposed Lease Amendment No. 1; and 2) other grants of ROW issuances or renewal(s), which would allow for the continued operation of the NGS and its associated facilities (described in Section 1.2.1 and **Appendix 1A**) on Navajo Tribal Trust Land through December 22, 2044. BIA also must approve the proposed relocation of portions of Navajo Route 41 within the proposed KMC permit area on Navajo and Hopi surface lands.

The purpose of the BLM action is to respond to the Proponent's request for ROW grants across jurisdictional public lands in Arizona, Utah and Nevada. The grants would be for operation, maintenance, and removal (as applicable) of the existing WTS and STS, existing critical access roads, and communication sites. The ROW grants would be issued pursuant to the Federal Land Policy and Management Act (43 USC Section 1761) as amended, which establishes the BLM's multiple-use mandate to serve present and future generations. Consequently, the need for the BLM action is established by the BLM's responsibility under the Federal Land Policy and Management Act to respond to the Proponent's request for ROW grants, while avoiding or minimizing adverse impacts to other resource values in accordance with BLM's land-use plans within the affected field offices. The BLM's decision would apply to those portions of the Proposed Action that involve BLM-managed public lands and the trust resources BLM is charged with overseeing. BLM also must act on the proposed KMC Resources Recovery and Protection Plan, as part of BLM's Indian minerals trust responsibility. BLM will consider approval of changes to the proposed KMC Resource Recovery and Protection Plan (mining plan) pursuant to 25 CFR Part 216; 43 CFR Part 3480.

Other U.S. Department of the Interior agencies having actions associated with the Proposed Action include the BIA's Western Region, U.S. Fish and Wildlife Service, and National Park Service. The USEPA, U.S. Army Corps of Engineers, and the U.S. Forest Service also have actions associated with the Proposed Action. **Table 1-1** lists all the federal agencies having an action to take and the specific action(s). These federal agencies were invited to become cooperating agencies in the preparation of this EIS.

Each of the federal decisions at issue must be consistent with federal Indian policies including, but not limited to, a preference for tribal self-determination and promoting tribal economic development for all tribes affected by these federal decisions. In addition, the federal government has a trust responsibility to protect and maintain rights reserved by or granted to Indian tribes and individuals by treaties, statutes, and executive orders.

At the end of this NEPA process, the Secretary of the Interior or designee will approve a Record of Decision establishing how the Department will proceed. Entities within the Department will take appropriate steps to implement this decision.

1.6 Non-federal Entities

1.6.1 Non-federal Agency Actions

Tribal, non-federal, state, and local government agencies with jurisdiction by law, or special expertise with respect to a potential environmental impact associated with the Proposed Action, were invited to become cooperating agencies (**Table 1-1**; CEQ 2002). The Hopi Tribe, Navajo Nation, and 10 central Arizona tribes with CAP water allocations (Ak Chin Indian Community, Fort McDowell Yavapai Nation, Gila River Indian Community, Pascua Yaqui Tribe, Salt River Pima-Maricopa Indian Community, San Carlos Apache Tribe, Tohono O'odham Nation, Tonto Apache Tribe, White Mountain Apache Tribe, and Yavapai-Apache Nation), were invited to become cooperating agencies. The Navajo Nation and Gila River Indian Community have become cooperating agencies in the preparation of this EIS. The Central Arizona Water Conservation District (operator of the CAP), and the Arizona Game and Fish Department also are cooperating agencies in the preparation of this EIS.

1.6.2 Non-federal Project Proponents' Interests, Goals, and Objectives

Certain non-federal NGS Participants seek to continue operation of the NGS beyond the current lease agreement termination date of December 22, 2019 through December 22, 2044. The NGS provides continuous, long-term, and cost-effective baseload power to its owners' customers in the southwestern U.S. using coal, a reliable and readily available fuel source from the Kayenta Mine. PWCC desires to continue providing an uninterrupted coal supply to NGS in order for NGS to continue power plant operations through December 22, 2044.

1.7 Historical Operations

The historical (pre-2020) operations of the NGS, the Kayenta Mine, and the transmission system and communication sites are briefly described in this section to provide sufficient understanding of how the facilities have been operated and will continue to operate through 2019, how operation of the facilities would change under the Proposed Action, and how operations would be different under any of the action alternatives described in Chapter 2.0. A more detailed description of these historical operations is provided in **Appendices 1B** and **1D**.

1.7.1 Navajo Generating Station and Associated Facilities

With the exception of a small portion of the Colorado River water intake structure (**Figure 1-3**), which is located on an easement from the National Park Service, the remainder of the NGS plant and its associated facilities Is located on approximately 3,485 acres of Navajo Tribal Trust Lands located in the northwestern portion of the Navajo Reservation near Page, Arizona. These lands are subject to the Lease and ROWs between the NGS Co-tenants and the Navajo Nation. An ash disposal site for coal combustion residual materials is located east of the NGS plant site. The BM&LP Railroad, with a total track length of approximately 80 miles with the turn-around at each end, delivers coal from Kayenta Mine's loadout silos to NGS (**Figure 1-1**). Total acreage of the landfills and other major components of support operations are provided in **Table 1-2**, and more detailed descriptions are in Section 1.7.1.7. A 323 Grant of ROW for an additional estimated 66 acres encompassing an overland conveyor within the proposed KMC, that was originally issued to SRP, has been transferred over to PWCC, because PWCC has control over its use and operation; the overland conveyor acreage is not included in **Table 1-2**.

Table 1-2 Acreage of Support Operations at NGS

Facility or Operation	Total Acreage
NGS plant site	1,021
Ash disposal site (landfill)	765
Road between plant site and ash disposal site	30
Lake pump station	5
Road between pump station and N22b	3
Pipeline, powerline, and road between lake and plant site	40
Coal loadout silo	100
Railroad corridor row	1,520
230-kV tie line	1
Total	**3,485**

Source: Navajo Project Operation and Maintenance Plan, Final, April 22, 2016. Numbers rounded for presentation.

Electrical power generated at NGS is transmitted to customers and the regional power grid through two existing transmission systems, the WTS and STS (also see **Figure 1-1**) via 500-kV transmission lines. The transmission systems' 19 communication sites are located on a mix of tribal, federal, state, municipal, and private lands.

NGS operations through 2019 are described according to the sequential steps required to convert the coal fuel to electrical energy for delivery to the regional transmission grid (**Figure 1-6**). Controls implemented to reduce pollutant emissions to the environment (air, soil, surface water, and groundwater) are summarized in this section, and described in greater detail in Chapter 3.0 under each applicable resource, and in **Appendix 1B**.

1.7.1.1 Coal Storage and Handling

The BM&LP Railroad delivers low sulfur bituminous coal from the Kayenta Mine to the NGS. Coal delivery, storage, and dust controls are described in **Appendix 1B**.

1.7.1.2 Power Generation

Three pulverized coal-fired steam electric generating units provide a combined net generating capacity of 2,250 MW. Each unit powers a steam turbine and includes a condenser, cooling tower, and cooling water handling operations as depicted in **Figure 1-6**.

Coal transferred from the coal hopper is treated with a calcium bromide agent (used to control mercury emissions), then is pulverized to the required specifications and fed into each boiler furnace. A flue gas treatment system is installed on each unit. Flue gas passes through the generating unit electrostatic precipitator and sulfur dioxide (SO_2) scrubber before exiting the 775-foot-high steel-lined concrete stack.

Boiler steam feeds the three NGS electric power generation turbines, each of which yields a gross output of up to 810 MW. Steam discharged from the turbines circulates over cooling tubes of the condenser where it is cooled for recirculation through the boiler units. Additional (make-up) water is added as necessary to maintain system operation. The heat from the circulating water is removed by evaporation in six cooling towers (two for each generating unit).

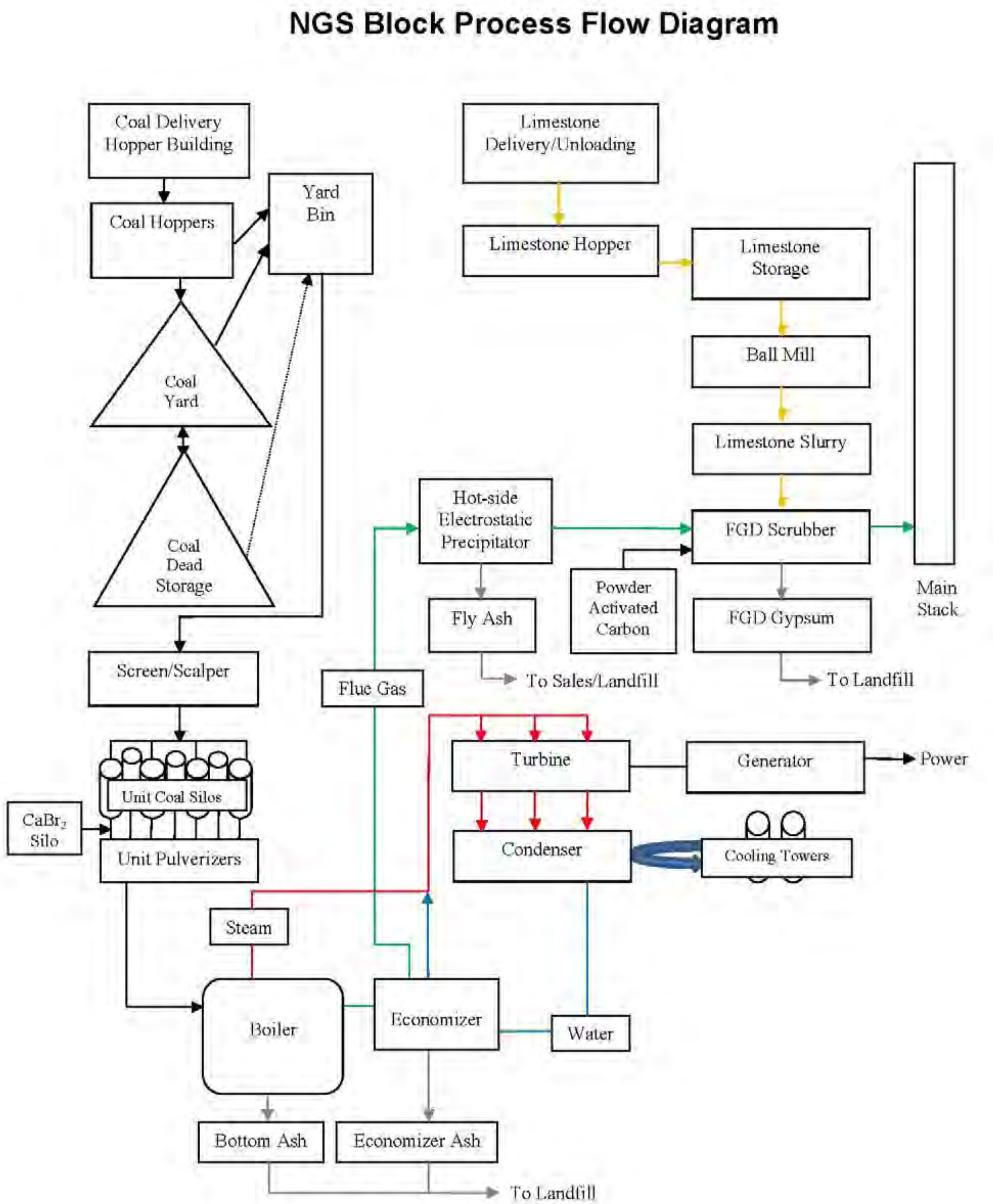


Figure 1-6 NGS Process Flow Diagram

The NGS was designed to function as a baseload plant, meaning that it was designed to operate most efficiently at near maximum output and as continuously as possible given maintenance requirements. Gross NGS annual energy output from 2009 to 2012 ranged from about 17.4 to 18.2 million megawatt-hours, with net annual output ranging from 15.8 to 16.9 million megawatt-hours. Those output levels represent a capacity factor of approximately 88 percent of design capacity. In 2014, total power production was 19,044,248 megawatt-hours with a net generation of 17,226,393 megawatt-hours, the difference of 1,817,855 megawatt-hours representing the load needed for internal plant operations. Routine operations, maintenance, repair, and other improvements are described in **Appendix 1B**.

1.7.1.3 Air Pollution Control Systems

1.7.1.3.1 Criteria and Hazardous Air Pollutants

Several air pollution control processes and systems are used to reduce emissions of mercury and hazardous air pollutants, nitrogen oxide (NO_X), particulate matter, and SO_2 from combustion flue gases. In sequence, the following activities and systems are utilized and operated to provide air emissions control.

- An electric railroad was installed to reduce emissions that would have otherwise occurred if the less expensive diesel locomotives were used.
- Fugitive dust is reduced by using baghouses at several coal and ash transfer locations inside the plant.
- Mercury emissions are reduced by mixing calcium bromide with the coal, prior to firing in the boilers. Calcium bromide is added to comply with the Mercury and Air Toxics Standards promulgated under 40 CFR 63 Subpart UUUUU.
- NO_X emissions are reduced in the boiler combustion process by low-NO_X burners that were installed on all three units, along with design modifications that were made to provide supplemental over-fire air systems, resulting in a reduction of approximately 40 percent of total NO_X emissions.
- Particulate matter at each unit is controlled by an electrostatic precipitator that is designed to capture 99.5 percent of fly ash. Particulate bound mercury is captured by these devices. The resulting “fly ash” is disposed of as coal combustion residual material, some of which also is sold as an additive to cement manufacturing.
- SO_2 emissions are reduced 90 percent by operation of a wet flue gas desulfurization scrubber that is downstream of the electrostatic precipitator. Limestone is delivered on-site, processed, and pulverized to make a liquid slurry that is mixed with the flue gases flowing through the scrubber. This mixing process captures SO_2 and other acid gases, including hydrogen chloride, which also is regulated as a hazardous air pollutant. The scrubbers also remove portions of mercury and particulate matter from the flue gas stream. The scrubber solids are processed and disposed of in the ash disposal landfill as coal combustion residual material.

Additional details regarding the emissions control devices for these units are provided in **Appendix 1B**.

1.7.1.4 Water Delivery, Use, and Treatment

The entire make-up water requirement for the three generating units is obtained from Lake Powell and delivered to the plant for a variety of functions at NGS including steam generation by the boilers, machinery bearing cooling, cooling towers, service water system, fire suppression system, and potable water. The lake pump station site is adjacent to the lake shore on a parcel of land leased to NGS by the Navajo Nation and includes the water intake wells and buildings that house pumps and electrical transformers. Five submersible first stage pumps lift the lake water to five second-stage booster pumps via independent pipelines, discharging the raw lake water into a discharge manifold. The manifold is connected to two 30-inch concrete cylinder supply lines that discharge at the power plant site into two

11-foot-diameter, 27-foot-high influent tanks that feed the make-up water clarifiers. The concrete cylinder pipelines for transporting the water to NGS, and the power lines from the plant's switchyard to the lake pump station for powering the pumps, are located within a 2.85-mile-long ROW. The pipelines are buried from 5 to 20 feet deep. The power lines, along with communications and control cables (fiber optic cables), are suspended from single wooden poles ranging from approximately 40 feet to 55 feet tall. Cathodic protection wells and monitors also are located within the ROW.

NGS is allocated 34,100 acre-feet per year for consumptive use, and 5,900 acre-feet per year for non-consumptive use. Over the past 15 years, annual consumptive water use has ranged from about 26,000 to 29,000 acre-feet per year. Water is treated, reused, and recirculated to the maximum extent possible to minimize withdrawals from Lake Powell. NGS is designed to be a zero liquid discharge facility, meaning that all water brought into the plant site is reclaimed, reused, and eventually evaporated such that no liquid is discharged from the plant site. The 5,900 acre-feet allocated for non-consumptive use has never been utilized.

NGS operates its own water treatment facility to remove hardness and adjust pH prior to use in the power plant systems. After treatment, the water stays in make-up reservoirs until it is distributed to various water systems that use softened water.

1.7.1.4.1 Potable Water

Water from Lake Powell is treated on-site at a water treatment plant and delivered via pipelines throughout the facility for drinking water and other potable uses. The facility is in compliance with requirements under Safe Drinking Water Act regulations.

1.7.1.4.2 Cooling Towers

The cooling towers at NGS are part of a circulating water system that provides cooling water to the main turbine condensers and bearing cooling water systems. NGS operates six cooling towers, two per unit. Each cooling tower is approximately 400 feet long and 3 stories tall (**Figure 1-7**).

Figure 1-7 One of Six Cooling Towers at Navajo Generating Station

Plant cooling water circulates repeatedly, and much of it is evaporated at the cooling towers. Evaporation results in higher solids concentrations in the cooling water system. To keep the solids concentration within acceptable limits, a cooling tower blowdown system draws off a circulating water stream which is replaced with fresh water. The circulating water containing high dissolved solids is sent to holding basins from which it is treated and recycled.

1.7.1.4.3 Wastewater Management

As noted above, NGS is designed to be a zero liquid discharge facility. Wastewater processing facilities are designed to recover and recycle cooling tower blowdown water and storm runoff from the developed area of the facility. Wastewater is processed through brine concentrators and a crystallizer, removing the solids and reclaiming water for reuse in the plant. A small amount of storm water runoff discharges offsite per a USEPA Multi-sector storm water general permit. A series of inter-connected lined wastewater holding ponds are used to store, transfer, and evaporate process water. Stormwater runoff from the ash disposal area is captured on-site and evaporated. Groundwater protection measures are used to prevent and monitor for any evidence of leakage from wastewater ponds. Sewage is processed in a step-aeration activated sludge treatment plant. The treated sewage effluent water is chlorinated and reclaimed back to water treatment influent for reuse. **Appendix 1B** provides additional details regarding wastewater treatment systems at NGS.

1.7.1.4.4 Groundwater Protection

A Groundwater Protection Plan has been implemented at NGS to ensure that water quality in the regional N-Aquifer, located approximately 900 feet below ground level, is not adversely affected by past, current, and future plant operations. The components of the plan that contribute to this effort include groundwater monitoring, formalized inspections and testing, engineering controls to avoid and minimize loss and transmission of NGS plant waters into the ground, measures to capture and reclaim water that has saturated soils, and implementation of additional Best Management Practices for protecting groundwater.

Three deep monitoring wells at the plant and ash disposal site provide monitoring of groundwater levels and water quality to ensure protection of the N-Aquifer. Recent improvements in engineering controls and monitoring have been implemented on several ponds. Additional pond liner system upgrades are scheduled in upcoming years on a prioritized basis. Installation and implementation of an extraction system for removal of shallow perched water from saturated soils beneath the main plant site began in May 2014 (see **Appendix 1B** for full description of the Groundwater Protection Plan).

1.7.1.5 Roadways and Traffic

Routine vehicle traffic occurs at NGS to provide operational support and maintenance. NGS receives numerous bulk deliveries of chemicals, diesel, and other products required for operation of the facility; types and quantities of chemicals delivered are summarized in **Table 1-3** and described in the sections that follow and **Appendix 1B**. Periodic deliveries of these materials, typically by large diesel-fueled trucks, are made throughout the year from various sources. Limestone deliveries are the most frequent and are required for operation of the SO_2 scrubber flue-gas desulfurization system used for SO_2 emission control.

Dozers, loaders, and other heavy equipment are used to manage the dead coal storage stockpile and perform other maintenance functions. NGS contractors operate vehicles and equipment, including off-road haulers, for use in dust suppression, fly ash hauling, and other operations.

1.7.1.6 Fuel and Chemical Storage and Use

NGS uses diesel fuel oil for its main boiler igniters, warm-up oil guns, and as the main fuel source for its auxiliary boilers. Gasoline and diesel for vehicle operations are dispensed from an on-site fueling station.

NGS requires a continual delivery of chemicals to maintain its operations. **Table 1-3** lists the primary material products delivered, number of deliveries per year, and the individual load size. The materials generally are delivered by heavy duty trucks from various suppliers.

Table 1-3 Historical Chemical Delivery to NGS

Product	Truck Deliveries (2014) Year	Load Size	Point of Origin
Limestone	3,664	25 ton, 37.2 ton, or 41 ton trucks	Apex, NV
Calcium Bromide	300-500	3,200 gallons	TBD
Powder Activated Carbon	TBD	TBD	TBD
Diesel	175	7,200 gallons	Holbrook, AZ: Phoenix, AZ; Las Vegas, NV; Farmington, NM; American Fork, UT
Ammonium Hydroxide	3	45,000 pounds	Salt Lake City, UT
Caustic soda	5	3,600 gallons	Buckeye, AZ
Sulfuric acid	151	3,300 gallons	Hayden, AZ
Lime	122	40 tons	Cricket Mountain, UT
Ferric sulfate	27	71,000 pounds	Salt Lake City, UT
Ferric sulfate	2	44,000 pounds	Salt Lake City, UT
Ferric sulfate	1	20,000 pounds	Salt Lake City, UT
Sodium hypochlorite	30	45,000 pounds	Henderson, NV
Hydrogen (liquefied)	11	111,000 cubic feet	Phoenix, AZ
Carbon dioxide (liquefied)	10	9.3 tons	Phoenix, AZ
Nitrogen (liquefied)	2	53,000 cubic feet	Tucson, AZ
Soda Ash	263	24 tons	Argus, CA

Note: Data is based on 2014 calendar year with the exception of calcium bromide, which is based on projected actuals. The quantity of powder activated carbon for mercury control is unknown at this time.

A site-specific Spill Prevention, Control, and Countermeasure Plan, described in **Appendix 1B**, identifies measures taken to prevent fuel oil discharges and mitigate the impact of any discharge to navigable waters of the U.S. A tank inspection program, earthen berms, and other structures are key provisions of this plan.

1.7.1.7 Landfills and Waste Management

SRP operates two landfills within the NGS lease area, one for coal combustion residual (ash) disposal, and one for asbestos disposal from dismantled facility components containing asbestos. Solid waste was previously disposed in an on-site landfill that has been inactive since 2015; all solid waste is now sent offsite to a regulated landfill. This section summarizes the facilities and operations for the two landfill facilities. The list of NGS landfills is provided in **Table 1-4** along with approximate surface areas.

Table 1-4 Summary of Landfills at NGS

Landfill	Wastes Handled	Surface Area (acres)
Ash Disposal	Coal combustion residual materials, including bottom ash, fly ash, economizer ash, and scrubber (gypsum) byproduct	765
Solid Waste (inactive as of 2015)	Office wastes, containers	13
Asbestos	Asbestos-containing materials	3

1.7.1.7.1 Coal Ash Disposal

Three different types of coal ash are created in the NGS boilers. Bottom ash is heavy ash that falls to the bottom of the boiler. Economizer ash is light ash that is carried part way through the boiler and falls out of the gas stream in the economizer section before it leaves the boiler. Fly ash is the lightest ash that leaves the boiler in the flue-gas stream, and is collected in the precipitators. Each of these ash types is handled and processed before being transported to the ash disposal site (**Figure 1-8**) or sold and recycled off site. The solid materials from the scrubber sludge (gypsum) byproducts also are disposed of at the ash disposal site. All coal combustion residual materials contain moisture before disposal; however, the ash disposal site is a dry landfill and does not use wet ponds to store ash waste. Because of the dry and warm climate residual moisture in coal ash is rapidly evaporated. **Appendix 1B** provides additional details of coal combustion residual characteristics and disposal operations.

Volumes of on-site ash disposal in 2014 were as follows:

- Fly Ash and Economizer Ash – 295,246 tons;
- Bottom Ash – 173,394 tons; and
- Scrubber byproducts – 458,048 tons.

A total of 380,739 tons of fly ash were sold off-site in 2014.

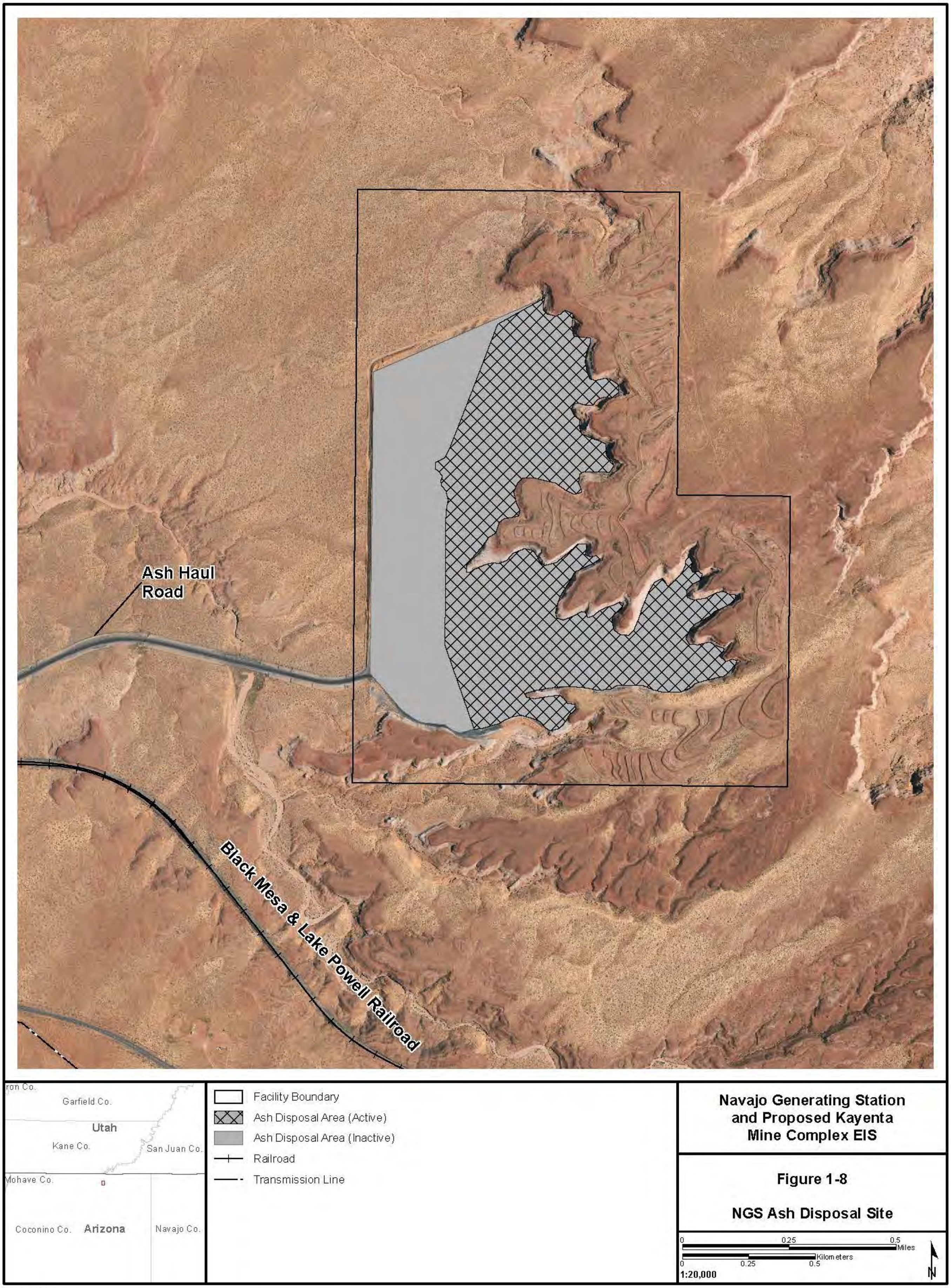
The ash disposal site is located approximately 1 mile east of NGS against the west edge of a sandstone outcrop. The ash disposal site is 765 acres, with a design capacity of 38 million cubic yards; approximately 50 percent of this design capacity remains available (see the Groundwater Protection Plan, **Appendix 1B**).

Terraced slopes within the ash disposal site contain areas of active disturbance and undisturbed areas that support native vegetation. The coal combustion residual (CCR) material is deposited in horizontal terraces against the steep vertical walls of the sandstone outcrop in individual layers or lifts not exceeding 15 vertical feet. The final top layer is covered with a 2-foot-thick layer of native soils and benched onto the adjacent natural ground; the bench areas are sloped to divert or minimize runoff. Closure of successive terraces minimizes the active portion of the ash disposal area.

The use of dry disposal in conjunction with the dry climate and geology of the region reduces the mobility and leachability (downward movement) of any of the CCR constituents. Furthermore, retention of stormwater runoff, dust control, and groundwater monitoring procedures ensure the CCR constituents are contained on site.

NGS Environmental Department personnel conduct landfill inspections at least monthly and take corrective action as needed. An NGS contractor provides a monthly summary to SRP on the amount of materials hauled off-site, materials stored on-site, and water used for dust suppression.

USEPA published its final Coal Combustion Residual Rule in the *Federal Register* on April 17, 2015. These wastes are regulated under Subtitle D of the Resource Conservation and Recovery Act as non-hazardous waste. Additional information can be found in **Appendix 1B**.



Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 1-8

NGS Ash Disposal Site

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1.7.1.7.2 Solid Waste Landfill

A 13-acre solid waste landfill (inactive in 2015) is located east of the railroad loop. When the landfill was active, a cover was applied to each cell in a manner that promotes runoff of water without excessive erosion. The cover was designed so surface water runoff will not leave NGS property or collect on the surface of the landfill.

A written closure plan utilizing Best Available Control Technology will be developed when final closure plans are complete.

1.7.1.7.3 Asbestos Landfill

The 3-acre asbestos landfill is located southeast of the railroad loop and accepts only asbestos waste generated at the plant site during abatement or demolition activities. It is permitted and managed as an active landfill in accordance with USEPA regulations. Restricted area signs have been installed at the gated entrance and along the perimeter fence. Operational and closure procedures for the asbestos landfill are provided in **Appendix 1B**.

1.7.1.7.4 Solid Waste Management

NGS utilizes waste minimization practices. Salvage materials include used equipment, instrumentation, and office furniture. Recycle materials include paper products, scrap metal, wood, fly ash, aluminum cans, plastic bottles, printer cartridges, electronic waste, fluorescent lights, rechargeable batteries, and tires.

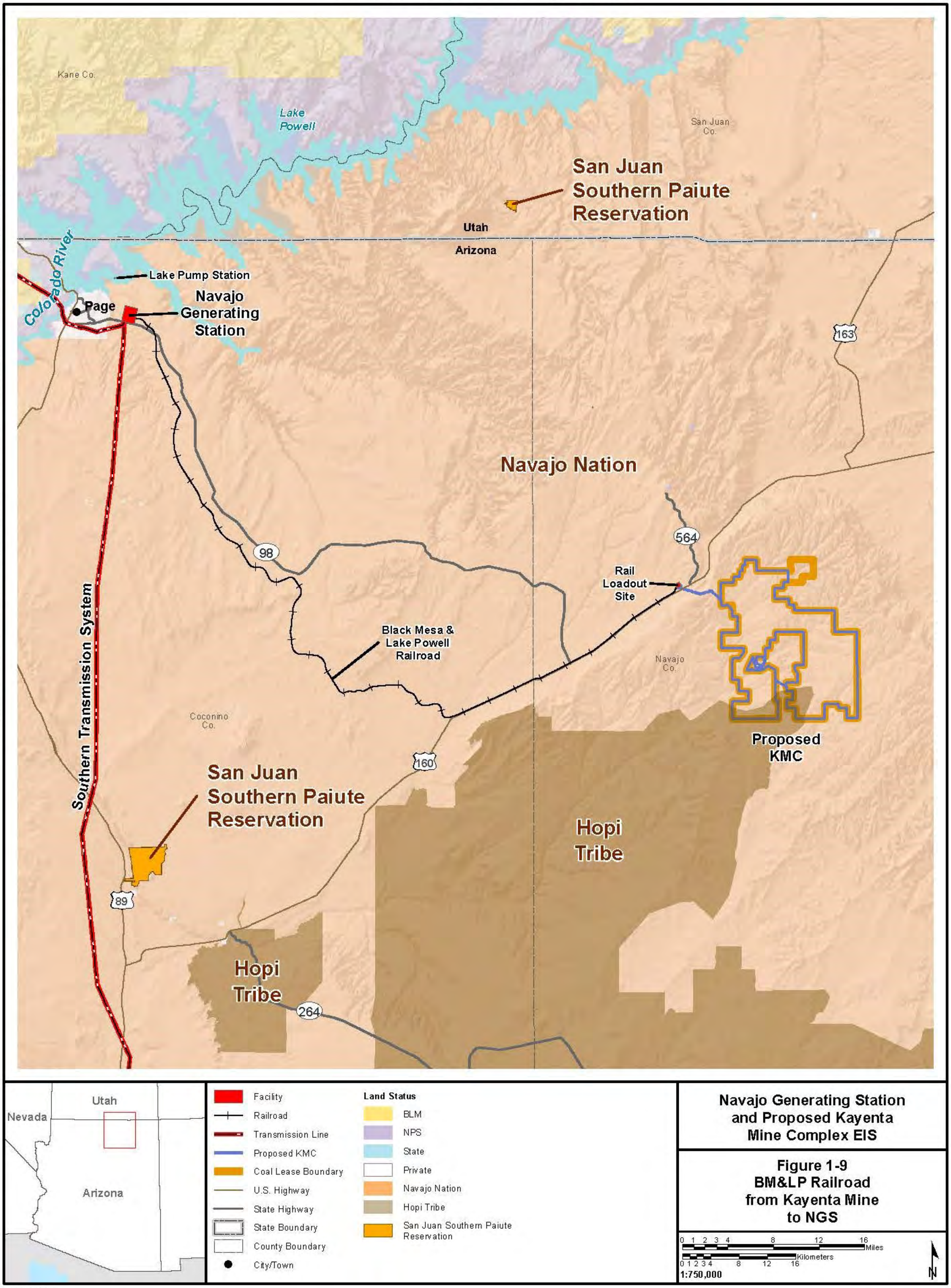
Service contracts are used to stage trash dumpsters throughout the plant site and when full to transport the waste material to off-site landfills. The amount of material sent to the NGS solid waste landfill decreased over the years, the landfill has been inactive since 2015 and deposited materials are controlled and subject to management approval.

1.7.1.7.5 Hazardous Waste Management

As a Small Quantity Generator, NGS implements a Hazardous Waste Minimization Plan using the best available and affordable waste management methods to minimize waste generation. Waste minimization includes a number of actions including eliminating and minimizing waste at the source, reclaiming, reusing material, and training. Waste minimization actions encompass a variety of techniques – technology or process modifications; reformulation or redesign of products; substitution of raw materials; and improvement in work practices (e.g., housekeeping, maintenance, and inventory control). Annual waste generation at NGS has decreased substantially from 39,000 pounds in 1991 to about 1,928 pounds in 2012.

1.7.1.8 Railroad and Coal Delivery to the Navajo Generating Station

The BM&LP Railroad is used to deliver coal from the Kayenta Mine to NGS and is not interconnected with any other rail lines. As shown in **Figure 1-9**, the track extends 78 miles northwest from the coal loading site near the Kayenta Mine on the north side of U.S. Highway 160, generally to the west then northwestward to NGS. Including the railroad loops at each end, the total length of the system is approximately 80 miles. When NGS is operating at full capacity, the train runs up to 24 hours per day, 7 days per week. Three round-trips are completed each day and approximately 8,000 tons of coal are delivered in each trip. Each 100-ton capacity railcar is filled to a level below the top edge to minimize spillage and wind exposure when the train is in motion. For most of its length, the rail is a single track. The Midway maintenance facility and a passing track/siding are located at milepost 42 near the center of the railroad line. Train operation is limited to a maximum of 50 miles per hour.



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The BM&LP Railroad is powered by a 50-kV overhead catenary system with energy purchased from the Navajo Tribal Utility Authority under an electric service agreement between Navajo Tribal Utility Authority and SRP on behalf of the NGS Participants. NGS is responsible for operating, maintaining, and improving all facilities required for the transformation and transmission of the electric power and energy for railroad operation from the NGS switchyard to the train.

Further details of railroad operations and safety measures are provided in **Appendix 1B**.

1.7.2 Proposed Kayenta Mine Complex

PWCC has been granted three coal mining leases over 64,858 acres by the Navajo Nation and Hopi Tribe (Section 1.1). Altogether, these coal mining leases provide PWCC the right to produce up to 670 million tons of coal.[12] Historically, the lease areas were mined as two separate operations: the Kayenta Mine, which supplies coal to NGS, and the former Black Mesa Mine, which supplied coal to the Mohave Generating Station through December 2005 after which the Mohave Generating Station was closed and decommissioned. The former Black Mesa Mine encompasses approximately 18,857 acres.

The Kayenta Mine continues to operate as the sole commercial coal provider to NGS. The Kayenta Mine encompasses an area of approximately 44,073 acres. **Figure 1-9** shows the existing permit boundary for the Kayenta Mine and **Figure 1-10** shows the Initial Program administration boundary for the former Black Mesa Mine. Activities in each mine area through 2019 are summarized below with additional details contained in **Appendix 1D**. The total lease area (64,858 acres) is slightly larger than the combination of the Black Mesa Mine and Kayenta Mine Permit Areas (62,930 acres).

In addition to the coal mining leases, PWCC also holds ROWs totaling approximately 456 acres: approximately 164 acres for an overland conveyor and rail loadout; approximately 283 acres for a coal haulage road, buried waterline, underground telephone line, transmission line, sedimentation ponds, utilities access, and maintenance roads and water well monitoring roads; and approximately 9 acres for a powerline corridor. There also are several monitoring sites scattered within the leasehold.

1.7.2.1 Kayenta Mining and Mine Support Facilities

1.7.2.1.1 Mining Requirements

A Permanent Program Permit, No. AZ-0001C was issued to Kayenta Mine on July 6, 1990. The currently approved Life-of-Mine Plan accommodates mining through 2026 at the current production rate (PWCC 2012 et seq.). As required under SMCRA, the permit has been renewed every 5 years since 1990; the current approved renewal for operations at the Kayenta Mine is from July 6, 2010, to July 5, 2015 (Permit No. AZ-0001E). A renewal application to cover the next 5-year renewal period (July 6, 2015, to July 5, 2020) is under separate review by OSMRE (PWCC 2012 et seq.). Because the Proposed Action of this EIS would begin December 23, 2019, the EIS assumes the pending 5-year renewal is issued for operations through December 22, 2019.

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[12] The coal-mining leases provide PWCC with the rights to prospect, mine, and strip leased lands to produce coal and kindred products, including other minerals that may be found, except for oil and gas. PWCC also is given the right to construct support facilities such as buildings, pipelines, tanks, plants, and other structures; make excavations, stockpiles, ditches, drains, roads, spur tracks, electric power lines, and other improvements; and to replace machinery and other equipment and fixtures and do all other things on the leased lands necessary to carry on mining operations, including rights of ingress and egress, and to develop and use water for the mining operations, including the transportation of coal mined from the leases.

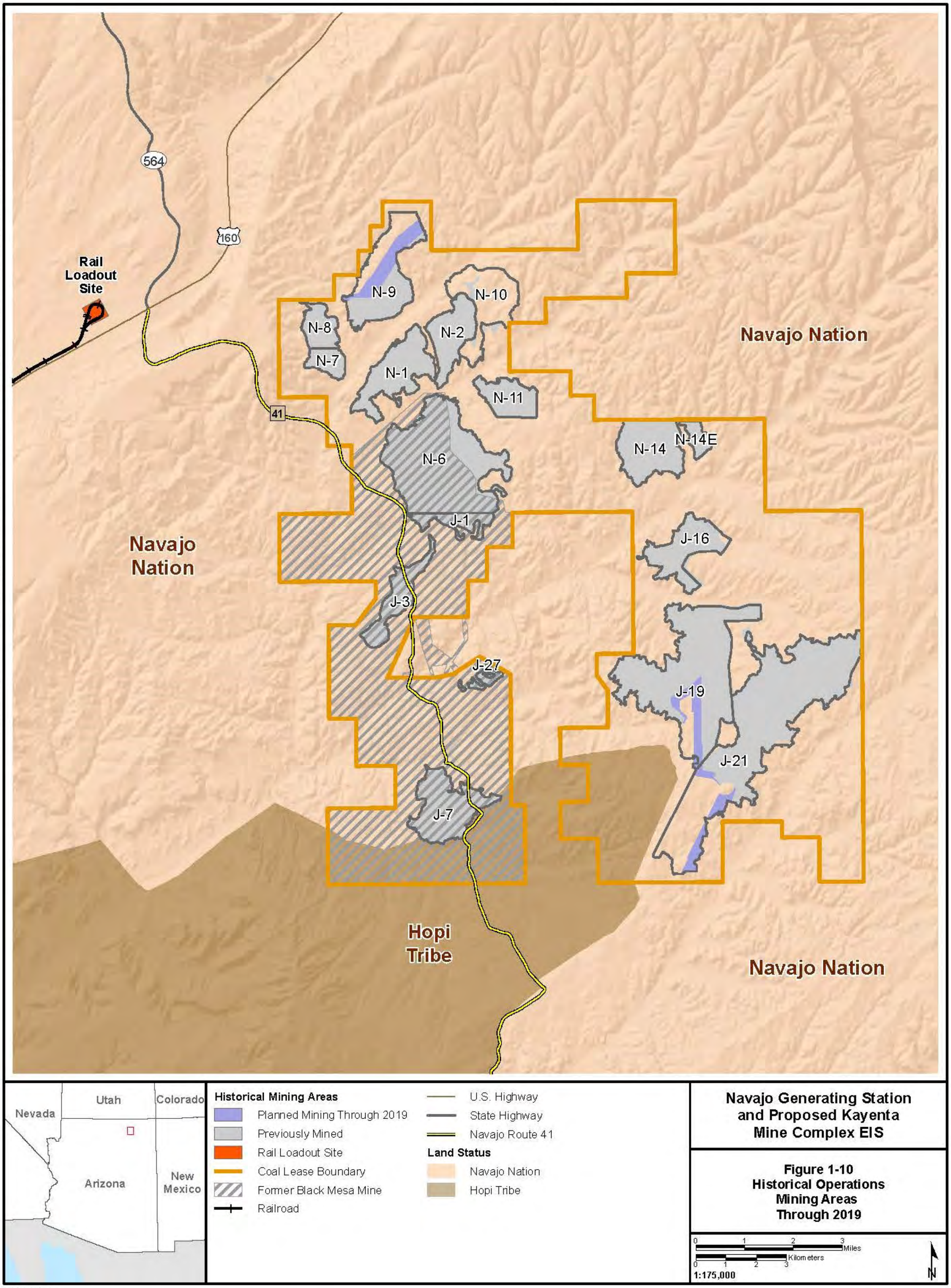

Figure 1-10 Historical Operations Mining Areas Through 2019

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Through December 22, 2019, the Kayenta Mine would continue to produce coal in three existing approved coal resource areas (J-19, J-21, and N-9). Annual production at the Kayenta Mine through 2019 would average approximately 8 million tons from the three mine areas, as shown in **Table 1-5**.

Table 1-5 Production Volumes through 2019 (from March 27, 2015 Life-of-Mine Plan Significant Revision)

Year	Mine Area J-19 (tons mined x 1,000)	Mine Area J-21 (tons mined x 1,000)	Mine Area N-9 (tons mined x 1,000)	Total (tons mined x 1,000)
2015	3,249.5	2,256.9	2,221.2	7,727.6
2016	3,323.5	2,056.7	2,190.8	7,571.0
2017	2,810.0	2,658.7	2,396.6	7,865.3
2018	2,831.8	2,843.8	2,293.4	7,969.0
2019	3,026.2	2,810.0	2,118.5	7,954.7

Coal is surface mined through conventional strip mining methods in a series of parallel pits in each mine area. Preparation and mining activities include clearing and grubbing, topsoil removal, blasting, overburden removal, coal removal, backfilling, and reclamation.

Historical mining operations at the Kayenta Mine utilize mine support facilities located on both the Kayenta Mine and the former Black Mesa Mine. This use is authorized under SMCRA and the existing permit; use of the support facilities was evaluated as part of the most recent renewal of Permit AZ-0001E. **Table 1-6** identifies the existing mine support facilities at each location that have received approval by OSMRE and are permitted for use as part of the operations at the Kayenta Mine. **Figure 1-11** shows support facilities for the proposed KMC.

Former Black Mesa Mine facilities that will continue to be used for Kayenta Mine operations through 2019 total approximately 566 acres; their land jurisdiction will change initial program lands to permanent program lands jurisdiction. These shared facilities and the associated acreage for each type of facility are described in **Table 1-7**. All other former Black Mesa Mine lands will remain as undisturbed lands, pre-law lands, or initial program land.

PWCC's permanent permit and SMCRA regulations allow for the placement of certain temporary storage facilities without prior approval from OSMRE. These include mulch storage areas; skid mounted fuel and water tanks; small skid mounted sheds and storage bins; fire, first aid, and portable toilet stations located in active working areas; small structures on foundation less than or equal to 100 square feet in size; and portable dragline power substations or transformers and trailing cable lines. The only Kayenta Mine support facilities planned for new construction through the end of 2019 are temporary sedimentation ponds, topsoil stockpiles, and ramp roads. All other support facilities discussed are existing facilities.

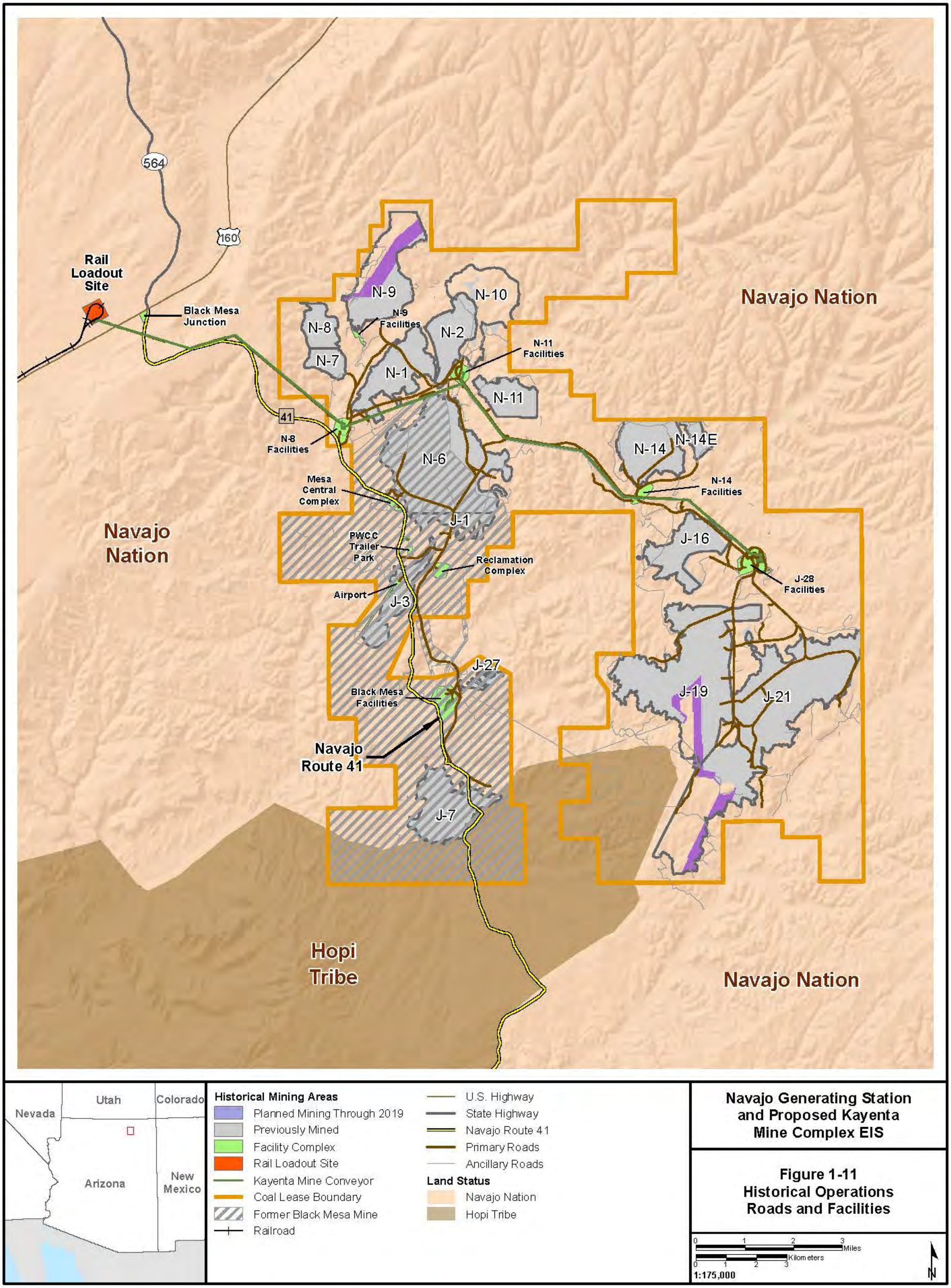
Haul trucks transport the excavated coal from the Kayenta Mine pits to coal-handling areas at J-28 Facilities and N-11 Facilities, where the coal is dumped into hoppers (**Figure 1-11**). If the hoppers are full, or the crushing operations are shut down, the coal is stockpiled at the coal-handling facility. At each coal-handling facility, the coal is crushed, and screened to minus 2 inches in diameter. Coal samples are taken to evaluate coal quality to meet NGS specifications. The coal is then conveyed from facilities at J-28 and N-11 to the central sorting and blending facility at the N-8 coal-handling facility. At the N-8 coal-handling facility, the coal quality is monitored, blended if needed, or stored prior to conveyance to the storage silos at the BM&LP Railroad loadout.

Table 1-6 Permitted Mine Support Facilities

Facility	Kayenta Mine	Former Black Mesa Mine
Facilities and Buildings		
Coal-handling and storage facilities	X	–
Mine warehouse buildings	X	X
Offices	X	X
Shops	X	X
Bath houses	X	–
Employee Trailer Park	–	X
Blasting materials storage silos and cap magazines	X	–
Equipment storage areas		
Sheds constructed on permanent foundations (>100 square feet in size)	X	X
Water-Related Facilities		
Fresh water storage facilities	X	X
Sedimentation ponds	X	X
Water diversions	X	–
Waterlines	X	X
Roads	X	X
Permanent fuel storage and tank farms	X	X
Airfield and associated facilities	–	X
Powerlines	X	X
Scoria Pits	X	X
Environmental Monitoring Facilities		
Air quality and meteorological monitoring stations	X	X
Surface water and groundwater quantity and quality monitoring sites (excluding ponds)	X	X

Table 1-7 Former Black Mesa Mine Facilities in Use for Kayenta Mine through 2019

Facility Type	Approximate Acreage
Facilities and Buildings	58
Water-Related Facilities - Sedimentation Ponds, Fresh Water Storage Facilities	71
Mine water supply wells and waterline	34
Roads	164
Airfield	85
Powerlines	61
Scoria Pit	91
Environmental Monitoring	2
Total	**566**



Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 1-11
Historical Operations Roads and Facilities

7/20/2016

1.7.2.1.2 Water Supply and Control Facilities

Water use and management facilities used for Kayenta Mine operations are located at both the Kayenta Mine and former Black Mesa Mine. **Table 1-8** indicates the number and locations of water use and management facilities. They are described in more detail in Section 3.7, Water Resources.

Table 1-8 Permitted Water Use and Management Facilities at the Proposed KMC

Type	Count	Total	Notes
Permanent Impoundment	23	50	Permanent impoundments
Permanent Impoundment (2015-2020)	1		
Permanent Impoundment (MSHA)	9		
Permanent Impoundment (RLRA)	6		
Permanent Impoundment (2015-2026)	—		
Internally Draining Permanent	11		
MSHA Size Structure (Temp)	2	115	Temporary impoundments
Temporary Impoundment	11		
Temporary Impoundment (2015-2020)	4		
Temporary Sediment Pond (2015-2020)	106		
Temporary Sediment Pond (2015-2026)	—		
J21W (2015-2026) (not in table)	—		
Temporary Impoundments	8	101	Reclaimed/Removed
Structure Reclaimed	81		
Structure Reclaimed (AZ-0001C)	2		
Structure Reclaimed (SAE)	9		
Structure Reclaimed (SAE) (Interim Program)	1		
Facility			
Water Diversions - Kayenta Mine	6	6	—
Water Diversions - Former Black Mesa Mine	0		
Water Quality and Quantity Monitoring Stations or Wells (excluding Ponds) - Kayenta Mine	48	69	
Water Quality and Quantity Monitoring Stations or Wells (excluding Ponds) - Former Black Mesa Mine	21		
National Pollution Discharge Elimination System Outfalls - Kayenta Mine	62	110	
National Pollution Discharge Elimination System Outfalls - Former Black Mesa Mine	48		

The Kayenta Mine obtains its water supply by pumping groundwater from three deep production wells (NAV-2, NAV-6, and NAV-8) located in the northwest part of the coal lease area. These wells were constructed to primarily withdraw water from the N-Aquifer, but wells NAV-2 and NAV-6 are open to both the N- and D-Aquifers (see Section 3.7.3 for a discussion of aquifers). Production wells NAV-6 and NAV-8 are located on the Kayenta Mine permit area. NAV-2 is located in the former Black Mesa Mine area. Four additional deep wells (NAV-3, NAV-4, NAV-7, and NAV-9) are located in the former Black

Mesa Mine area; none are actively used for production.[13] Historic annual groundwater withdrawals ranged to a high of approximately 4,500 acre-feet per year, but after 2005, they have been approximately 1,200 acre-feet per year and are not expected to change through 2019 (**Figure 1-12**). Most pumped water is used for dust control, coal preparation, and domestic (potable and sanitation) purposes.

In accordance with federal regulations, PWCC controls sediment and runoff discharges from disturbed areas using both structural and non-structural best management practices. PWCC primarily uses sedimentation ponds to prevent, to the extent possible, additional contributions of suspended solids and sediment to streamflows or runoff outside the permit area resulting from mining disturbance. All surface drainage from the mining disturbed areas is routed through a siltation structure prior to leaving the permit area. All sedimentation ponds provide adequate detention time to allow suspended solids to settle out and to ensure effluent from the ponds meets applicable tribal and federal effluent limitations. PWCC has a point-source discharge permit under the National Pollution Discharge Elimination System Program for point source discharges from sedimentation ponds. The USEPA also has granted PWCC coverage under their Multi-Sector General Permit for Stormwater Discharges Associated with Industrial Activities for any precipitation-related discharge not covered under the existing National Pollution Discharge Elimination System Permit (i.e., for those precipitation-related discharges which are not routed through a siltation structure). For additional information on National Pollution Discharge Elimination System and stormwater discharges see Section 3.7.

A cooperative permit program is used by the OSMRE, USEPA, Tribal agencies, and the BIA to review the sediment control plan and associated technical documentation in accordance with SMCRA and Clean Water Act jurisdictions. The USEPA administers the National Pollution Discharge Elimination System permit in coordination with both the Navajo Nation and Hopi Tribe, and sets effluent limitations and monitoring and reporting requirements for releases of treated effluent to receiving waters. All National Pollution Discharge Elimination System permit requirements are implemented by PWCC. There are 62 National Pollution Discharge Elimination System outfalls (permitted locations that discharge to receiving waters) for PWCC operations at the Kayenta Mine area. Another 48 National Pollution Discharge Elimination System outfalls are located in the former Black Mesa Mine area. An additional provision in the National Pollution Discharge Elimination System permit is that PWCC shall continue to implement the Seep Monitoring and Management Plan, designed to: 1) identify and characterize seeps; 2) identify seeps that may pose a threat to water quality; and 3) establish BMPs at seeps determined to pose a threat to water quality. Tribal water quality requirements are specified as general discharge standards in the National Pollution Discharge Elimination System permit, with the objective of minimizing pollutant discharges and their effects on human health, public safety or welfare, and aquatic plants and animals.

Most of the runoff and sediment control features associated with the National Pollution Discharge Elimination System permit are relatively small detention structures that are built, maintained, and then reclaimed as mining and mine reclamation activities proceed across the landscape. However, approximately 21 permanent impoundments are to remain on reclaimed surfaces at the Kayenta Mine to provide post-mining stock watering and wildlife habitat. These structures have been identified in consultation with OSMRE and tribal representatives.

[13] On April 25, 2016, PWCC notified OSMRE that NAV-7 was completely reclaimed and is no longer usable. Additionally, NAV-4 has been rehabilitated.

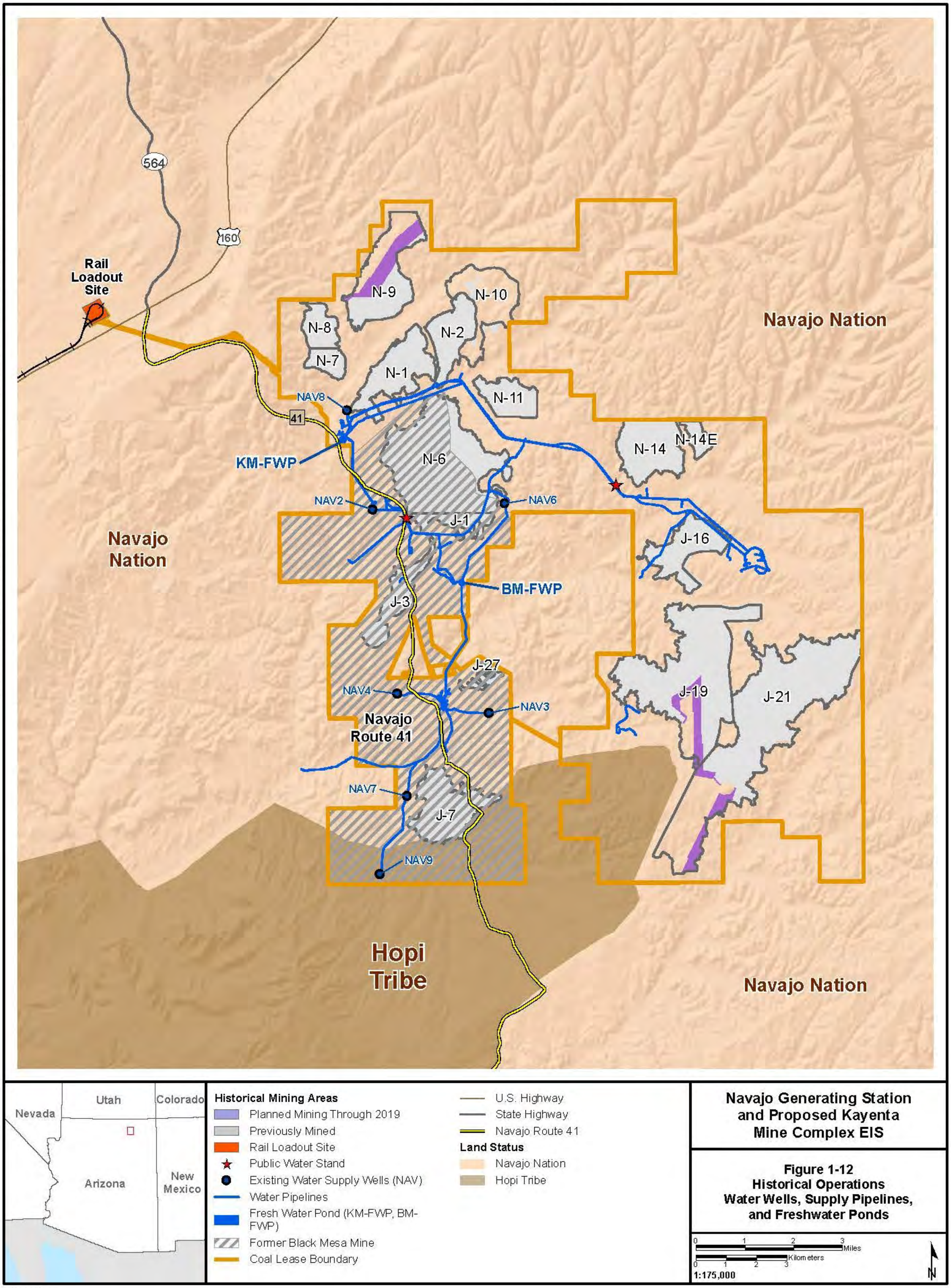


Figure 1-12
Historical Operations
Water Wells, Supply Pipelines,
and Freshwater Ponds

7/25/2016

The Mine Safety and Health Administration requires further engineered designs, construction, inspections, and maintenance for dams that meet greater height and/or storage capacity criteria in 30 CFR Part 77.216. PWCC has constructed and operated nine impoundments at the Kayenta Mine that meet the MSHA criteria. Storage capacities of the MSHA impoundments at Kayenta Mine range from approximately 22 to 724 acre-feet.

Stream channel diversions were constructed to maintain surface hydrologic conditions while facilitating removal of the coal resource. Under SMCRA permit AZ-0001C, PWCC constructed five diversions in the early 1980s. The original five are all on ephemeral stream reaches at the Kayenta Mine. One of these, along Coal Mine Wash, trends along the boundary between the Kayenta Mine and the former Black Mesa Mine. An additional diversion was constructed in 1993. This sixth diversion was designed and built to be a permanent feature on Reed Valley Wash on the northern boundary of the J-19 coal resource area at Kayenta Mine, and it is classified as an intermittent stream section. All of these structures have been designed, built, and maintained according to standard hydrologic and hydraulic engineering practices, and approved through applicable regulatory programs.

1.7.2.1.3 Roads

Roads within or crossing the mine permit areas are classified in four categories: Primary roads, ancillary roads, ramps (or routes of travel which are within the mining and spoil grading areas), and non-mining related roads (public and private) (**Figure 1-11**). Public roads are roads constructed for public use and financed, maintained, and administered by a government entity. There are two public roads which lie within or in close proximity to the Kayenta Mine and former Black Mesa Mine areas. U.S. Highway 160 lies north of the Kayenta permit boundary. Navajo Route 41 crosses through the Kayenta permit boundary and areas of the former Black Mesa Mine and provides access to U.S. Highway 160 to the north and Navajo Routes 4 and 65 to the south.

1.7.2.1.4 Fuel, Vehicle and Equipment Maintenance, and Explosive Materials Storage

Fuel and related petroleum products stored on-site for use include unleaded gasoline, diesel and Jet A-fuel, and lubricants. Maintenance-related products and spent products that are handled, stored, and used include antifreeze, solvents, lubricating oils, and greases. Bulk lubricants are delivered in 55-gallon drums or trucked in and delivered to aboveground storage tanks. Fuels are delivered by common carrier via tanker truck and are stored at both the Kayenta Mine and support facilities at the former Black Mesa Mine. These products are stored in aboveground storage tanks which are protected by primary and secondary containment. There are no underground storage tanks at the former Black Mesa Mine or Kayenta Mine. In addition, a portion of the diesel fuel stored at the Kayenta Mine area is mixed with ammonium nitrate to form an ammonium nitrate and fuel oil mixture, which is used for blasting overburden, parting, and coal in the mine areas.

PWCC maintains Spill Prevention, Control, and Countermeasure and Emergency Procedures plans describing measures to prevent fuel oil discharges and emergency response to mitigate impacts of any spills. The plans are reviewed and updated as needed, but at least once every 5 years and within 6 months of any change in facility design, construction, operation, or maintenance that materially affects the spill potential of the facility.

Blasting operations at the Kayenta Mine are conducted according to federal law, applicable regulations, and the approved permit. See **Appendix 1D** for a description of strategies to protect the public and livestock from blasting activities and Section 3.14 for information related to residential notifications and pre-blasting surveys.

1.7.2.1.5 Solid and Hazardous Waste Disposal

No disposal of solid wastes currently occurs within the PWCC mine leasehold boundary. PWCC contracts with a solid waste vendor to haul the solid waste off-site to a regulated landfill. No hazardous chemical wastes, radioactive materials, hazardous sludges and liquids, or any other type of hazardous waste are discarded within the entire leasehold area. All regulated wastes, as defined by the Resource Conservation and Recovery Act and other regulations, are shipped off-site for recycle or disposal in accordance with applicable federal, tribal, and state regulations.

Hydrocarbon-contaminated soil was discovered during excavation and removal of underground storage tanks at both the Kayenta Mine and former Black Mesa Mine areas. PWCC constructed an on-site bioremediation facility, referred to as a land farm, east of the J-16 mining area to remediate the contaminated soil. The land farm was managed in accordance with USEPA and NNEPA requirements. The bioremediation process has been completed, and NNEPA approved the final closure reports on May 14, 2014. PWCC will reclaim the land farm area in accordance with the approved reclamation plan.

1.7.2.1.6 Airfield

PWCC maintains a private airfield and associated facilities within the former Black Mesa Mine permit area, as one of the facilities used by the Kayenta Mine. The airfield is located on the surface of reclaimed mine area J-3 and consists of a 7,500-foot-long by 75-foot-wide asphalt paved runway, a small airplane tie-down ramp area, taxiway, aviation fuel storage area, and storage building. The airfield is typically used only during daylight hours but is equipped with runway lights that can be used for an emergency night landing. The facility was designed, constructed, and is maintained to comply with applicable local and federal regulations.

1.7.2.1.7 Air Quality Control and Monitoring

Key operations and activities in the pit areas subject to air quality control and monitoring include:

- Overburden and coal drilling and blasting;
- Overburden removal by dragline, backhoe, and loader;
- Coal removal by front-end loader or backhoe;
- Topsoil removal by scrapers;
- Road maintenance by graders;
- Dozer activity;
- Truck haulage of overburden;
- Truck haulage of coal from the pit area to the prep area; and
- Natural wind erosion of disturbed areas.

Other key operations outside of the pit area include:

- Coal preparation;
- Coal crushing; and
- Coal conveyance.

A summary of emission sources, control technologies, and the effectiveness of these technologies is provided in **Appendix 1D**.

Air emissions from Kayenta Mine operations are highly dependent on the location of ongoing mining, and result from a range of operations considered to be sources of fugitive emissions. Kayenta Mine overburden and coal removal occur at three coal resource areas. Coal removed from the northern coal resource area (N-9) is hauled by truck to the N-11 coal preparation area (prep area), where it is crushed, screened and transferred by conveyors to the N-8 prep area. Coal removed from the southern coal resource areas (J-19 and J-21) is hauled by truck to the J-28 prep area where it is crushed, screened, and conveyed to the N-8 prep area. The conveyors are covered, but not fully enclosed. The majority of transfer points on the conveyor system are fully enclosed. **Figure 1-10** provides an overview of the mining areas that will be active through 2019 at the Kayenta Mine.

Air quality and meteorological monitoring are conducted both at the Kayenta Mine and the former Black Mesa Mine. There are three separate meteorological monitoring sites, nine precipitation monitoring sites, and 14 separate air quality monitoring sites for particulate matter with an aerodynamic diameter of 10 microns or less. They are located on both the Kayenta Mine and former Black Mesa Mine areas. **Figure 1-13** depicts the locations of the separate monitoring sites.

1.7.2.1.8 Regulatory Jurisdiction and Bonding Requirements

The Kayenta Mine is required to have all mine plans approved by the OSMRE as the regulatory authority for coal mining and reclamation on Native American lands. Mine reclamation falls into one of three programs depending on when disturbance occurred; Pre-law, Initial Program, or Permanent Program. Pre-law lands are those that were disturbed prior to December 16, 1977, and have not been re-disturbed since. This is prior to the passage of the SMCRA and the effective date for Initial Program regulations, and Pre-law requirements pursuant to the lease terms pertain to reclamation of these lands. Initial Program lands are those that were disturbed between December 16, 1977, and the issuance of the Permanent Program permit for the Kayenta Mine in 1990. Mine reclamation must meet the requirements of the SMCRA and the Initial Program for Native American lands. Permanent Program lands are those lands disturbed after the issuance of a Permanent Program permit issued by the OSMRE pursuant to the SMCRA regulations. Lands that are disturbed under the Permanent Program permit are subject to the performance bonding requirements of the Permanent Program as described in 30 CFR Part 800. The amount of the performance bond is determined by OSMRE based on the requirements of the approved permit and reclamation plan. The amount must be sufficient for OSMRE to complete the reclamation work hiring a third party contractor. As reclamation is completed on Permanent Program affected lands, PWCC can request release of all or a portion of the performance bond through OSMRE.

Section 3.14, Land Use, provides Pre-law, Initial Program, and Permanent Program acreages. All future permitting would occur under the Permanent Program. Section 3.14 also discusses reclamation requirements and status of reclamation for Initial Program and Permanent Program affected lands. The bond release process and status for Permanent Program lands also is discussed. **Figure 3.14-1** shows the status of reclamation for the KMC.

1.7.2.1.9 Abandonment/Decommissioning

Decommissioning of mine facilities occurs when facilities are no longer required to support mining activities, unless the facility has been approved by OSMRE as a permanent facility. No facility decommissioning has occurred or would occur through 2019.

1.7.2.1.10 Community Programs

As part of its community liaison efforts, PWCC is active in programs at the Kayenta Mine to relocate residences in areas located near future blasting areas or within coal recovery areas (see the Relocation and Compensation subsection of Socioeconomics - Section 3.18). In addition, PWCC provides emergency medical services, access to potable water, water hauling for livestock, snow removal on area roads, coal, firewood, and managed grazing. Coal is made available (free or at a cost) to members of the community, and as areas on the mine are cleared for mining, firewood is made available from slash piles. Managed grazing on reclaimed lands is provided to some residents.

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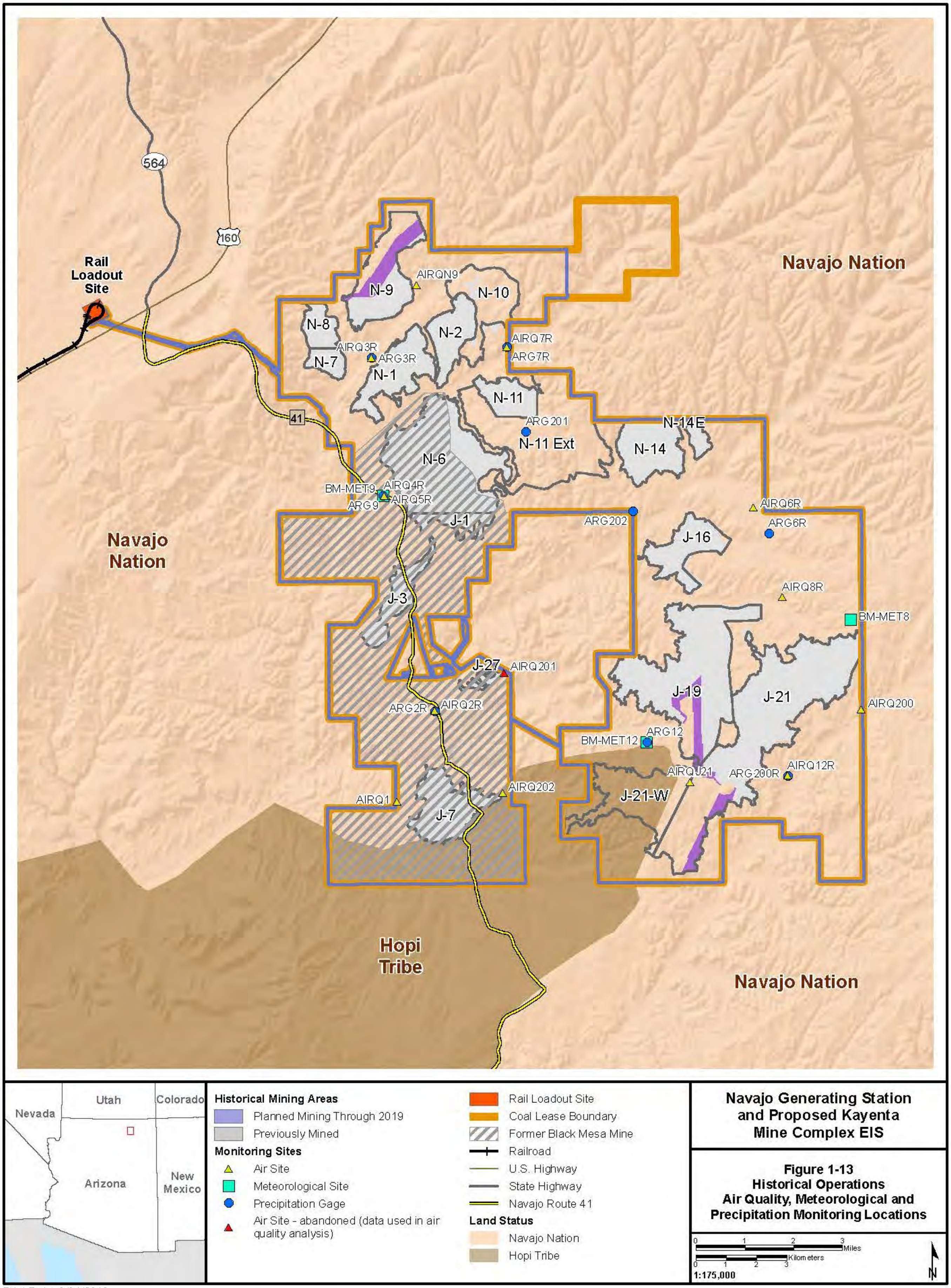

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Figure 1-13
Historical Operations
Air Quality, Meteorological and Precipitation Monitoring Locations

Print Date: 8/31/2016

PWCC provides two water stands where local residents can obtain potable water for personal use: the first is located along Navajo Route 41 just south of the Mesa Central Complex within the former Black Mesa Mine area, a second stand is located west of the N-14 facilities. Approximately 30 to 40 acre-feet of water is provided to the community from these water stands on an annual basis. PWCC currently is working with the Navajo Nation to provide water for a community water system known as the Many Mules Water Project adjacent to the Kayenta Mine. PWCC also is working to put in place the necessary agreements to provide water from the mine water distribution system and other necessary infrastructure to the Navajo Nation and the Hopi Tribe at the conclusion of mining.

PWCC periodically opens slash piles from clearing an area being prepared for mining at the Kayenta Mine, to allow firewood gathering by the local community. The community is notified by signage indicating the location and timing to gather firewood from the controlled locations where the slash is stored.

PWCC makes coal from the Kayenta Mine available to individuals in the local area; some coal is provided free while other coal is provided at cost. Coal is provided free to employees, individuals living in close proximity to the mine, and financially disadvantaged community members. Tribal Chapters may obtain coal for distribution, typically to disadvantaged or elderly members of the chapter. Individuals who are given or sold coal are provided with a pamphlet on the proper usage to minimize indoor air emissions.

Although not required to open reclaimed areas for grazing, PWCC evaluates plant biomass annually and determines if reclaimed areas can support grazing and, if so, the amount and duration of grazing the area can support. Managed grazing is allowed on up to 11,400 acres, which have vegetative cover to support grazing. PWCC cooperates with the local Tribal Chapters to encourage appropriate use levels and to provide preference to families with historic grazing rights in the area. Due to drought and overgrazing conditions, PWCC temporarily suspended livestock grazing in 2015 to improve range conditions and has indicated it will likely reinstate grazing in the future during average or better years.

Under the Initial Program for the Kayenta Complex, PWCC consults with OSMRE, BIA, and landowners to determine when an area is ready for grazing per 30 CFR Part 715.20(e)(2) which specifies: the regulatory authority, in consultation with the permittee and the landowner or in concurrence with the governmental land managing agency having jurisdiction over the surface, shall determine when the revegetated area is ready for livestock grazing. No grazing consultation/approval requirements for the Permanent Program lands are found under 30 CFR Part 816. PWCC currently provides water sources for stock watering through installation of temporary and permanent impoundments. These ponds are located throughout the mined areas.

1.7.2.2 Former Black Mesa Mine and Mine Support Facilities

1.7.2.2.1 Mining and Mining Support Facilities

The former Black Mesa Mine supplied coal to the Mohave Generating Station, located near Laughlin, Nevada, from 1970 to December 2005. PWCC suspended mining operations in December 2005 due to the closure and decommissioning of the Mohave Generating Station. Previously mined areas of Black Mesa Mine have been reclaimed, but not all support facilities associated with the mine areas, such as sedimentation ponds and roads, have been fully reclaimed. No new mining is planned for the former Black Mesa Mine.

1.7.2.2.2 Mine Support Facilities Used for Kayenta Mine

Some support facilities at the former Black Mesa mine currently are used to support mining at the Kayenta Mine and will continue to be used to support operations at the Kayenta Mine through 2019 (see **Tables 1-6** and **1-7**). These facilities are located on approximately 566 acres of the former Black Mesa Mine.

1.7.2.2.3 Support Facilities Not Used for Kayenta Mine

Support facilities at the former Black Mesa Mine not being used for the Kayenta Mine include the Black Mesa Mine truck shop, warehouse, and foreman offices; welding shop; electrical shop; bath house; administration building; coal-handling facilities; coal laboratory; quonset hut; and ready-line and compressor house. Former Black Mesa Mine facilities not being used by the Kayenta Mine, if not requested by the Navajo Nation for their use, will be reclaimed.

A portion of the existing, inoperable coal slurry pipeline and water storage tank associated with the Black Mesa Pipeline facilities are located within the former Black Mesa Mine area. Approximately 200 feet of the pipeline lies within the mine area boundary as the pipeline corridor extends away from the former Black Mesa Pipeline facilities. The pipeline is inoperable and is not part of PWCC's existing and approved operations. Additionally, the Black Mesa Pipeline facilities are not owned by PWCC, are not part of PWCC's existing operations through 2019, and are not part of the Proposed Action. Plans for reclaiming these facilities by the facility owner currently are under review by OSMRE.

1.7.2.2.4 Water Use and Management

As previously discussed, mine water supply production wells NAV-2 through NAV-4, NAV-7, and NAV-9 are on the former Black Mesa Mine area and comprise part of the pumping operations to provide water for use and hydrologic monitoring at the Kayenta Mine. These groundwater withdrawals are pumped through water lines to storage tanks, collection ponds, and water stands located in the former Black Mesa Mine area or at roadside distribution points. The Black Mesa Mine fresh water pond also is located near the Black Mesa Reclamation Complex.

There are approximately 49 sedimentation structures and impoundments constructed on the former Black Mesa Mine operations area. All of these features have been designed, built, and operated in accordance with federal regulations and current permit provisions. Approximately 31 of the temporary structures have been reclaimed. Approximately 12 permanent impoundments are to remain on reclaimed surfaces within the former Black Mesa Mine operations area at the end of 2019 to provide post-mining stock watering use and habitat. These structures have been identified in consultation with OSMRE and Navajo Nation Water Resources staff.

There are approximately 48 National Pollution Discharge Elimination System outfalls (discharge locations) for PWCC operations at the former Black Mesa Mine operations area that can be organized into the following three categories based on types of disturbance and their discharges:

- Alkaline Mine Drainage (19 outfalls);
- Coal Preparation Plants, Storage Areas, and Ancillary Area Runoff (9 outfalls); and
- Western Alkaline Reclamation, Brushing and Grubbing, Topsoil Stockpiling, and Regraded Areas (20 outfalls).

PWCC has constructed and operated two impoundments on the former Black Mesa Mine that meet MSHA criteria. These structures have been designed, built, and maintained in accordance with regulations. Total storage capacities of the MSHA impoundments range from 179 to 669 acre-feet.

Stream channel diversions were constructed to maintain surface hydrologic conditions while facilitating removal of the coal resource. Under SMCRA permit AZ-0001C, PWCC constructed five diversions in the early 1980s. All of these except the Coal Mine Wash diversion are within the Kayenta Mine operations area as previously described. The Coal Mine Wash diversion trends along the boundary between the former Black Mesa Mine and Kayenta Mine boundaries. This feature has been designed, built, and maintained according to standard hydrologic and hydraulic engineering practices, and approved through applicable regulatory programs.

1.7.3 Transmission Systems and Communication Sites

Energy from NGS is delivered on 500-kV transmission lines on the WTS and STS (**Figure 1-14**) to points of delivery (Moenkopi switchyard and McCullough, Westwing, Yavapai, Cedar Mountain, Dugas, Morgan, and Crystal substations) for the NGS participants as specified in NGS operating agreements. The facilities comprising the transmission system (transmission lines, substations, and communication sites) all are part of the western electric grid and; therefore, all have independent utility (i.e., their renewals would be sought even in the absence of NGS).

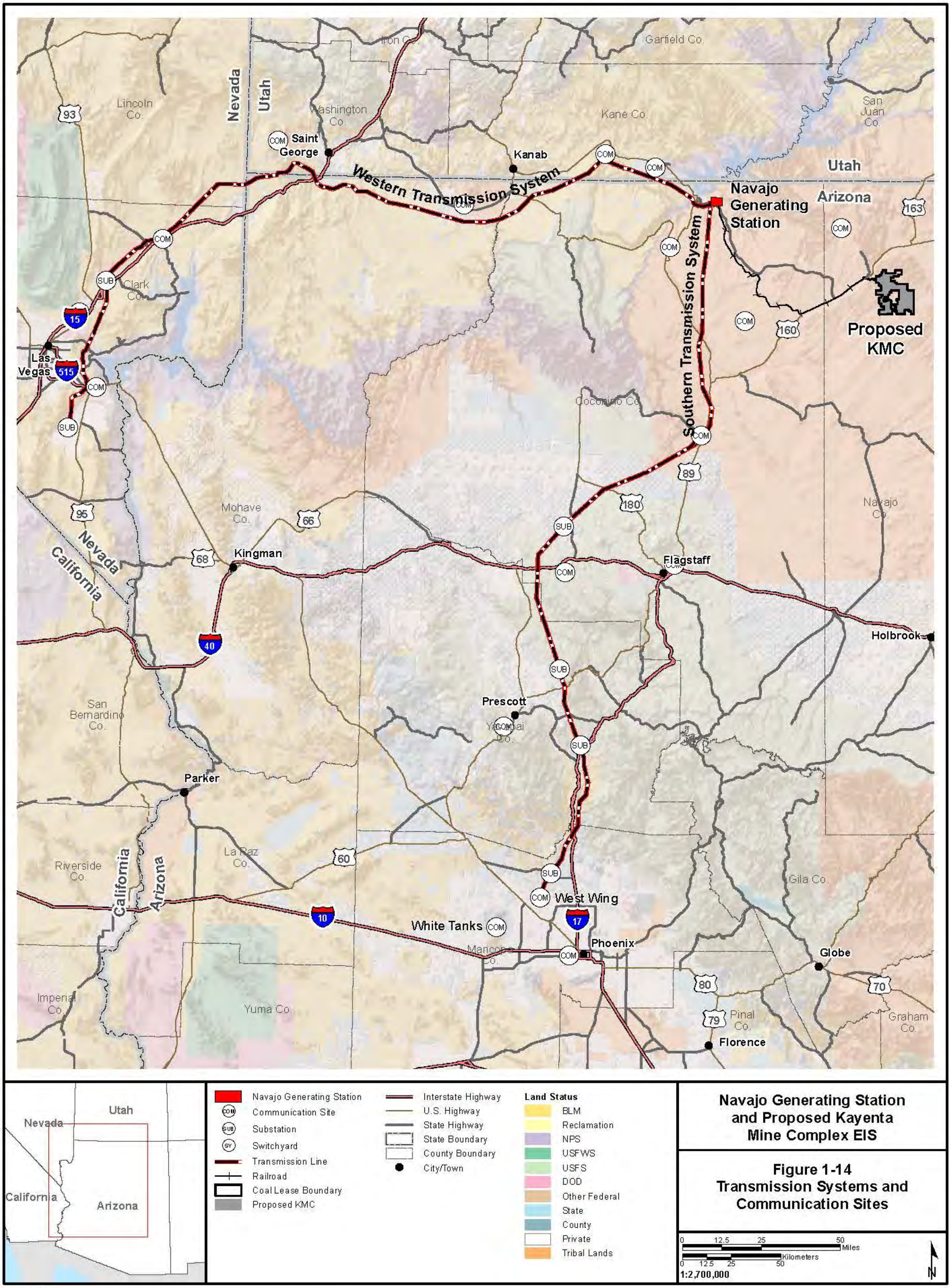
The WTS is administered by the Los Angeles Department of Water and Power and on-the-ground operation and maintenance is performed by NV Energy. The power line begins at NGS east of Page, Arizona, and generally heads west along the Utah-Arizona border. From there it turns to the southwest into Nevada through the BLM-administered Moapa Corridor that traverses through the Moapa Indian Reservation, through to the Crystal substation located northeast of Las Vegas. It turns south at the Crystal substation and continues to its terminus at the McCullough substation located approximately 14 miles southwest of Boulder City, Nevada. The total line distance in Arizona, Utah, and Nevada is 275 miles and occurs across various land owners as shown in **Table 1-9** and detailed in **Appendix 1B**.

The STS is operated and maintained by Arizona Public Service. This transmission system consists of two parallel, high-voltage transmission lines that begin at NGS east of Page, Arizona. The eastern line is referred to as the Westwing Line and the western line is referred to as the Moenkopi Line (together the parallel lines are often referred to by Arizona Public Service as the “500-2” line). The Moenkopi Line connects to the Moenkopi switchyard and Cedar Mountain and Yavapai substations and terminates at Westwing substation. The Westwing Line connects to the Dugas and Morgan substations and terminates at the Westwing substation. Except for a small segment near Moenkopi, the lines are within a common corridor (ROW). The total STS power line distance in Arizona is 256 miles and occurs across various land owners as shown in **Table 1-9** and detailed in **Appendix 1B**.

Table 1-9 Surface Ownership/Management for Lands Crossed by WTS and STS

Ownership/Management by State	WTS (miles)	STS (miles)	Total (miles)
Arizona Total	**121**	**256**	**377**
Bureau of Indian Affairs	6	96	101
Bureau of Land Management	87	27	115
Bureau of Reclamation	-	1	1
National Park Service	3	-	3
Private Land	12	20	33
State	12	47	59
U.S. Department of Agriculture Forest Service	-	65	65
Nevada Total	**109**	**-**	**109**
Bureau of Indian Affairs	14	-	14
Bureau of Land Management	81	-	81
Bureau of Reclamation	7	-	7
Private Land	8	-	8
Utah Total	**45**	**-**	**45**
Bureau of Land Management	33	-	33
Private Land	0	-	0
State	12	-	12
Grand Total	**275**	**256**	**531**

Note: Numbers rounded for presentation and individual rounded numbers may not equal the numbers presented as totals.



Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 1-14
Transmission Systems and Communication Sites

7/20/2016

There are six substations/switchyards interconnected to the STS and two on the WTS, besides the commonly shared switchyard at the NGS plant. The specific infrastructure and equipment contained within each site varies, but generally each switchyard or substation contains power transformers; switching devices such as circuit breakers and disconnects to cut power; and measurement, protection, and control devices needed to ensure its safe and efficient operation. There is an access road into each site, and all sites are surrounded by security fencing. Repairs and maintenance occur within the existing footprint.

The 19 communication sites, which support operations of the plant, railroad, and transmission systems, are shown on **Figure 1-14**. The communication sites are located within the boundaries of the NGS, substations, or in remote locations that are at sufficient elevations to facilitate line-of-sight transmission to one or more other sites. Redundant power is installed at the NGS and substations to back up the communication equipment; propane fueled generators provide backup power at remote sites. Remote sites are fenced, and many of the sites are co-located with other users' equipment. Operation and maintenance, installation and replacement of equipment, and access are coordinated with those other users.

Inspections, maintenance, and repair of the communication sites are conducted on an as-needed basis, usually once a year or less. Typical maintenance activities include: building and antenna structure repair and maintenance, communication equipment maintenance and upgrades, clearing of vegetation within the site grounds and at fence line to prevent fires, roof repair and replacement, replacement of weathered cables, and repair of access roads (**Appendix 1B**).

1.8 Relationship of this Proposed Action to Other Activities

1.8.1 U.S. Environmental Protection Agency Actions

The Clean Air Act, passed by Congress in 1970, was amended in 1977 to include the Regional Haze Rule to reduce haze and pollution that decrease visibility. In August 2014, the USEPA promulgated a Federal Implementation Plan for implementing the Regional Haze Rule to reduce NO_X emissions at NGS that can contribute to regional haze at 11 Class I areas (e.g., National Parks, wilderness areas) within a 300-kilometer radius surrounding the NGS. In the view of the NGS Participants, USEPA's originally proposed Best Available Retrofit Technology (BART) rule may have resulted in the NGS Co-tenants shutting down the plant for economic reasons. The BART Federal Implementation Plan rule was consistent with a "better than BART" proposal submitted to USEPA as part of an agreement developed by a group of stakeholders known as the Technical Work Group. The Technical Work Group included SRP on behalf of the NGS Co-tenants, the U.S. Department of the Interior, Central Arizona Water Conservation District, the Navajo Nation, the Gila River Indian Community, the Environmental Defense Fund, and Western Resource Advocates. This diverse group of stakeholders was committed to finding an operational approach that would allow the continued operation of NGS, and includes commitments by the U.S. Department of the Interior to reduce air emissions and study opportunities to transition the federal share of NGS from coal over time. The BART Federal Implementation Plan includes provisions to shut down one unit by 2020—or operate the NGS plant with NO_X emissions equivalent to a one-unit shut down—and install selective catalytic reduction or equivalent technology on the operating units by 2030. This EIS incorporates implementation of the Federal Implementation Plan under the Proposed Action and all action alternatives, since implementation of the plan would occur post-2019.[14] More information about the Regional Haze Rule Federal Implementation Plan and the Technical Work Group Agreement is provided in **Appendix 1C**.

[14] As of the release date of this document, the Regional Haze Rule Federal Implementation Plan has been challenged in four legal proceedings, which have been consolidated and are currently in the U.S. Court of Appeals for the Ninth Circuit. The outcomes are pending and their status will be updated as new information is available.

Pursuant to the Clean Air Act, Section 111(d), USEPA published a final "Clean Power Plan" on October 23, 2015 (80 Federal Register 64662), that would regulate carbon emissions from existing utility-sized fossil-fuel fired generating units within the lower 48 states, and located on tribal lands of the Navajo Nation, Ute Indian Tribe, and Fort Mojave Indian Tribe. The rule establishes an ultimate 2030 emission performance limit for each jurisdiction subject to the rule, plus interim emission limits beginning in 2022 to provide for a transition to the more stringent 2030 emission performance limits. The 2030 performance limits are designed to reduce carbon emissions nationally by 32 percent compared to 2005 emission levels. The final plan would require a state or tribe to use an emission rate-based performance plan (pounds/megawatt-hours) or alternately, a mass-based performance plan (tons carbon dioxide emitted per year). States must have approved plans by 2018, and must implement their approved plans to meet their respective interim and final emission limits starting no later than 2022. A tribe with one or more affected electric generating units located on its lands will have the opportunity, but not the obligation, to apply for eligibility to develop a Clean Air Act Section 111(d) implementation plan. The tribe would need to be approved by the USEPA as eligible to develop and implement a Clean Air Act Section 111(d) plan pursuant to Clean Air Act Section 301(d) and the procedure set forth in 40 CFR Part 49. If the tribe does not have an adequate implementation plan, for whatever reason, USEPA will implement federal implementation plan provisions if USEPA finds it necessary or appropriate to do so under 40 CFR Section 49.11.[15]

USEPA has not yet made a final determination as to whether or not it is necessary or appropriate to directly implement the final Clean Power Plan on Navajo Nation lands, should the Nation choose not to seek a tribal implementation plan under Section 111(d) and 40 CFR Part 49.

For more information on this final rule, see: https://www.epa.gov/ cleanpowerplan/clean-power-plan-existing-power-plants#federal-plan.

The effect of the Clean Power Plan on future operations at NGS is currently unknown, pending resolution of legal challenges to the rule, as well as a final determination regarding implementation of the Clean Power Plan on Navajo Nation lands.

1.8.2 Joint Federal Agency Work Group

On January 4, 2013, the U.S. Department of the Interior, USEPA, and the Department of Energy issued a "Joint Federal Agency Statement" regarding NGS, which commits the three agencies to work together toward goals that produce:

> ...(i) clean, affordable and reliable power; (ii) affordable and sustainable water supplies, and (iii) sustainable economic development, while (iv) minimizing negative impacts on those who currently obtain significant benefits from NGS, including tribal nations. (Joint Federal Agency Statement 2013)

[15] On February 9, 2016, the U.S. Supreme Court granted a stay on the Clean Power Plan stopping implementation pending disposition of legal challenges in the U.S. Court of Appeals for the District of Columbia Circuit.

A federal NGS Working Group was formed to oversee the activities undertaken in support of the Joint Federal Agency Statement, which include collecting sound, scientifically based information on issues relating to the NGS for the federal government, and helping the three agencies work with stakeholders to develop a roadmap for the long-term future of NGS.

National Renewable Energy Laboratory, part of Department of Energy, issued a Phase 1 Report in January 2012 entitled “Navajo Generating Station and Air Visibility Regulations: Alternatives and Impacts” under an Interagency Agreement between U.S. Department of the Interior and Department of Energy. The purpose was to address in one study, information on all the issues affecting NGS for the USEPA to consider in its development of the BART proposed rule for NGS. A second report under Phase 1 on clean energy alternatives, the “Navajo Generating Station and Clean-Energy Alternatives: Options for Renewables,” was published by National Renewable Energy Laboratory in June 2012 to lay the groundwork for further research on clean energy alternatives to NGS (National Renewable Energy Laboratory 2012a,2012b. See Section 2.3.1.1 for additional discussion.

The National Renewable Energy Laboratory continues work with a series of proposed studies referred to as the “National Renewable Energy Laboratory Phase 2 Study.” The National Renewable Energy Laboratory Phase 2 Study, which is funded and overseen by Reclamation, assumes post-2019 operations of NGS and investigates actions that could be taken to replace the energy associated with the federal share in NGS. The National Renewable Energy Laboratory Phase 2 Study will define a portfolio of clean energy and non-coal generation alternatives that minimizes negative impacts to those who currently obtain significant benefits from NGS in a glidepath to operate the CAP after 2044.

In support of the goals of the Joint Federal Agency Statement, Reclamation is working with Native American tribes affected by the Proposed Action. Reclamation has entered into a cooperative agreement with the Navajo Nation to assist in the preparation of a Navajo Clean Energy Development Plan, which will be used to advance the Navajo Nation’s Clean Energy Policy. Reclamation and the Hopi Tribe are entering into a cooperative agreement to assist in developing a Hopi Clean Energy Strategic Plan. Reclamation and the Gila River Indian Community (GRIC) are entering into a cooperative agreement to assist in developing a GRIC Renewable Energy Study. The tribal clean energy studies will inform the NGS roadmap, identify tribal clean energy economic development opportunities and renewable energy options to replace a portion of NGS energy for the CAP.

Other initiatives are being pursued, as well. One such tribal technical assistance initiative is being undertaken by the National Renewable Energy Laboratory, Reclamation, Western Area Power Authority and the Northern Arizona University, to formulate an inter-tribal renewable energy marketing mechanism.

1.8.3 California and Nevada Legislation Regarding Use of Fossil Fuels

As noted in Section 1.1, the Los Angeles Department of Water and Power executed an asset purchase agreement with SRP on July 1, 2016. This agreement was initiated as a result of California State Senate Bill 1368, which limits long-term investments in baseload generation by California utilities to power plants that meet certain emissions performance standards. Under the asset purchase agreement, SRP acquired Los Angeles Department of Water and Power’s 21.2 percent interest in NGS generation through 2019. After 2019, this amount of power and energy will no longer be generated at NGS. Los Angeles Department of Water and Power intends to continue participation in the NGS transmission systems and communication sites and to continue transmission of electricity generated from other sources.

Nevada State Senate Bill 123 requires certain Nevada utilities to develop a plan to reduce emissions from coal-fired electric generating plants and calls for the replacement of the capacity of such plants with increased capacity from renewable energy facilities and other electric generating plants. Pursuant to State Senate Bill 123, NV Energy will be divesting its 11.3 percent generation interest in NGS by December 31, 2019. NV Energy currently intends to continue receiving its share of NGS generation through December 22, 2019. A separation agreement between NV Energy and the remaining NGS Participants is anticipated to be executed prior to that date. NV Energy has expressed its intentions to continue participating in the NGS transmission systems and communication sites beyond 2019, and to continue transmission of electricity generated from other sources. Decisions by NV Energy on how and when it would exit from its participation in the NGS plant could affect the manner in which compliance with the Regional Haze Rule's Federal Implementation Plan is undertaken at NGS and its timing. Such decisions could also affect the form of any continuing lease of the plant site with the Navajo Nation (a lease amendment if all of the current Co-Tenants continue as owners or, alternately, a new lease agreement among the Navajo Nation and the continuing NGS owners only). In the event of a new lease, the terms of such agreement would be substantively similar to those in Lease Amendment No 1.

1.8.4 Navajo Nation Option to Acquire an Ownership Interest in Navajo Generating Station

Lease Amendment No. 1 would provide a right of first refusal and purchase options for the Navajo Nation to acquire up to 170 MW of generating capacity in the event of specified divestiture actions. The divestiture by Los Angeles Department of Water and Power on July 1, 2016, triggered the buy-in option for the Navajo Nation. A decision by the Navajo Nation to exercise the option could result in changes in the shares of generating capacity available to other Co-tenants. As discussed in Section 1.8.3 above, there are current unknowns associated with NV Energy's exit from NGS.

The results of ownership changes brought about Los Angeles Department of Water and Power, NV Energy, and Navajo Nation purchases and sales would primarily affect the allocation of capacity to each NGS Participant, but not the upper and lower limits of production (the range is described in Section 2.3.1). Therefore, the analysis takes into account the possible range of ownership scenarios after 2019, all of which fall within the upper and lower limits of production.

1.8.5 Navajo Nation Primacy

Currently OSMRE is, and would remain the primary regulator of coal mining under the SMCRA until the Navajo Nation demonstrates that it has developed a regulatory program that meets all of the requirements in the SMCRA and implementing regulations issued by OSMRE.

If the Navajo Nation submits and receives approval of its proposed regulatory program from OSMRE, it would become the primary regulator within the Navajo Nation reservation lands and would assume responsibility over permitting, inspection, and enforcement activities for coal mining activities. OSMRE then would provide oversight of the Tribe's implementation of the regulatory program.

The date of enactment of the Navajo Nation SMCRA is the critical date that drives the schedule for submission and approval of the Navajo regulatory program. The Navajo Nation is hopeful that it can bring the Act before the Navajo Nation Council for approval in 2016; if approved, the Act would likely take effect in 2017.

1.9 Government-to-government Consultations

Pursuant to Executive Order 13175 (Consultation and Coordination with Indian Tribal Governments), the Department of the Interior has conducted government-to-government tribal consultation as detailed in **Table 1-10**. Additional government-to-government tribal consultations and informal tribal consultations will occur at key project stages and as requested by tribal governments.

Table 1-10 Government–to–Government Tribal Consultations to Date

Tribe	Date	Location	Agencies Represented
Navajo	March 31, 2014	Window Rock, AZ	Reclamation, OSMRE, BIA-Navajo Region
	July 21, 2015	Window Rock, AZ	Reclamation, OSMRE, BIA- Navajo Region
	July 19, 2016	Window Rock, AZ	Reclamation, OSMRE, BIA- Navajo Region
Hopi	May 16, 2014	Kykotsmovi, AZ	Reclamation, OSMRE
	May 15, 2015	Kykotsmovi, AZ	Reclamation, OSMRE
	March 7, 2016	Kykotsmovi, AZ	Reclamation, OSMRE
	June 22, 2016	Kykotsmovi, AZ	Reclamation, OSMRE, BIA-Western Region
CAP-affected Tribes	May 15, 2014	Phoenix, AZ	Reclamation, BIA- Western Region
	April 14, 2015	Phoenix, AZ	Reclamation
Kaibab Band of Paiute Indians	July 3, 2014	Pipe Spring, AZ	Reclamation, OSMRE, BIA-Western Region
	April 16, 2015	Pipe Spring, AZ	Reclamation
	February 18, 2016	Pipe Spring, AZ	Reclamation
Hualapai	March 4, 2016	Peach Springs, AZ	Reclamation
Pueblo of Zuni	February 16, 2016	Zuni, NM	Reclamation, OSMRE

1.10 Public Scoping

Scoping is defined in NEPA's implementing regulations (40 CFR Part 1501.7) as "an early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to the proposed action." The following sections provide an overview of the scoping process, results, and the primary impact issues brought up during scoping that are addressed in the EIS.

1.10.1 Public Scoping Outreach Process

On May 16, 2014, Reclamation published a Notice of Intent in the *Federal Register* announcing the intent to prepare an EIS for the NGS-KMC Project. The Notice of Intent described the Proposed Action and alternatives under consideration, described public comment opportunities, and provided the locations, dates, and times of the open house scoping meetings. The Notice of Intent initiated the scoping period, which was scheduled to continue through July 7, 2014 (61 days).

Public outreach activities prior to the June public scoping meetings included advertisements and news releases placed in local and regional newspapers; a notification letter to government agencies, elected officials, and non-governmental organizations; postcards and newsletters distributed to a mailing list of over 760 entities; public service announcements aired on local radio stations in both the Navajo and Hopi languages; and meeting notification fliers and public information summaries distributed to Navajo chapter houses, Hopi community centers, and libraries in the project area. A community-based training video in English, Navajo, and Hopi languages also was made available on the NGS-KMC Project public website. This video provided a tutorial on the NEPA process and public involvement in the NGS-KMC Project EIS process.

1.10.2 Public Scoping Meetings

Reclamation held 10 public scoping meetings from June 10, 2014 to June 20, 2014 (see meeting locations and dates in **Appendix 1E**). The meeting sites were located to encourage participation from tribal governments, communities near the NGS and the proposed KMC, and water users in the CAP service area. The scoping meetings were held in an informal open house format where members of the public could arrive at any time during the published 3-hour time period. Two court reporters were available at each scoping meeting to record oral comments. At scoping meetings held on the Navajo and Hopi Reservations, Navajo and Hopi interpreters were available to assist attendees in conversing with project team members and to help interpret oral comments made to the court reporters.

A project video was developed and made available at each scoping meeting in English, Navajo, and Hopi languages to provide an overview of the NEPA process, public involvement opportunities, and suggestions on how to provide substantive comments on the Proposed Action and environmental resource areas that should be considered in the analysis.

An additional poster station overview handout, comment form, and fact sheet were supplied for the informal conferences, required by SMCRA regulations for the Kayenta Mine permit revision application. These informal conferences were held by OSMRE concurrently with the Reclamation open house scoping meetings at Forest Lake Chapter, Kayenta, and Kykotsmovi.

1.10.3 Additional Meetings on the Hopi Reservation

At the request of the Hopi Tribe, Reclamation reinitiated and extended the public scoping comment period by publishing a *Federal Register* notice on July 25, 2014, announcing extension of the public scoping comment period through August 31, 2014. This extension provided an opportunity for expansion of public involvement activities including community outreach meetings and an additional scoping meeting on the Hopi Reservation.

Public outreach activities (similar to those conducted in June 2014) were completed prior to the August 2014 public scoping and community meetings. Two community outreach meetings plus an additional scoping meeting were held in August 2014 on the Hopi Reservation to respond to a request from the Hopi Tribe to provide additional opportunities to obtain information and to comment. The format and the information presented at the community outreach and scoping meetings were the same and matched the format of the 10 open house scoping meetings held in June 2014. Written comments were accepted at all three meetings. Attendees were notified that comments could be submitted by mail, fax, or email; court reporters were present to record oral comments from the public only at the August 14 scoping meeting.

1.10.4 Public Scoping Participation

Meeting attendees were encouraged to sign in at the welcome table. In total, 228 people signed in at the June open house scoping meetings; 45 people signed in at the supplemental August 2014 meetings on the Hopi Reservation.

1.10.5 Public Scoping Comments

Scoping comments were submitted by the public in several different ways: at scoping meetings in the form of written (hand written or typed submissions or completed comment forms) or oral submission (recorded by court reporters as verbatim transcripts); as emails or attachment to emails sent to NGSKMC-EIS@usbr.gov; in written format (letters) delivered via U.S. mail or other delivery method, or as a memorandum from another federal agency.

After comments were received, each submittal was reviewed to identify the comments that could best assist the EIS team to determine issues to be analyzed in the EIS or to gather information that would be useful as background information for the analysis.

The individual comments were then assigned one or more classifications, based on their content, and entered into a database. Each comment in the database was attributed to the commenter (if known), the affiliation of the commenter (if stated), and associated in the database to the original submittal.

Table 1-11 provides the sources and numbers of comment submissions. Multiple comments were often provided in individual submissions.

Table 1-11 Commenter Type or Affiliation

Commenter Type/Affiliation	Number of Comment Submissions
Individual	66
Federal Agency	2
State or Local Agency	3
Non-governmental Organization/Special Interest	23
Business	4
Tribe	12
Total Comment Submittals	110

The public scoping report for this project is provided as **Appendix 1E** to this Draft EIS. Details on public outreach, information provided at scoping meetings, public participation summaries, and a detailed summary of the public comments received by resource topic are contained in the Scoping Summary Report. The Scoping Summary Report is available at http://www.ngskmc-eis.net.

1.11 Summary of Issues

The general theme of public scoping input was the tradeoff between the continued economic and social benefits of coal mining and lower-cost coal-fired power generation, and the adverse environmental and social effects of these activities. Public scoping comments reflected local community opinions about the past, current, and future operations of the individual project components (the power plant, the coal mine, and electrical transmission and distribution in central/southern Arizona). Comments also addressed broader national concerns related to the continued burning of coal as a contributor to regional haze and global climate change.

Concerns related to NGS focused on effects of plant stack emissions and fugitive dust from coal ash disposal areas, on local and regional air quality and ecological and public health. Natural gas, wind, and solar generation were endorsed as possible alternatives to replace or partially replace NGS operations. Several renewable energy alternatives located on tribal lands were suggested.

General concerns related to the Kayenta Mine included the effects to Black Mesa resulting from mining that individuals perceive as the cause of irreversible changes in Navajo and Hopi community sustenance, traditional uses, and religious experiences associated with certain places such as springs. The long history of mining on Black Mesa has resulted in several environmental and social issues that influence input to the current EIS process. The most frequently expressed historic concerns are the effects of past industrial uses of groundwater underlying Black Mesa, the treatment of cultural resources and burials within areas to be mined, and public health concerns related to fugitive dust from mining operations.

Because many Navajo and Hopi community members work as mine employees, live near active mining areas, and traverse part of the mine permit area on public and local roads, there is a constant engagement between the mine operator (PWCC) and the local community. This engagement was expressed in both positive and negative terms. The following are some specific issues of public concern related to mine operations:

- Effects of fugitive dust, blasting, and changes in surface water quality from mining operations on the health of residents living near the mine;
- The magnitude and duration of mine-related groundwater pumping effects on spring and channel flows, and on wells that support human and livestock use;
- Mine reclamation practices that meet the regulatory requirements, but also should consider and support traditional uses (wildlife, plants for cultural use and food, livestock);
- Active mining safety concerns that limit access by community members to water sources and grazing areas;
- The identification, treatment, and protection of archaeological resources, sacred sites, and burials on areas to be mined;
- The likelihood of relocation of residents living near the mine;
- The employment and economic benefits to the Navajo Nation and Hopi Tribe from mining; and
- Current and future status of public services provided to the local community by PWCC, including creation and access to surface water sources, public road maintenance, and provision of coal used for winter heating.

The major concern expressed by the Central Arizona Water Conservation District and some of the tribes that receive CAP water was the future cost of irrigation, municipal, and industrial water (from both surface water and groundwater sources) that would be delivered by electricity generated by NGS or other sources. Other concerns included potential changes in the Development Fund contributions that are provided by NGS surplus power generation sales and potential effects on future tribal water rights settlements that may involve CAP water.

Because of the large geographic area affected by the project components and the prior history of mining on Black Mesa, a variety of comments were received on the assessment of cumulative impacts of past, present, and future actions. Of particular concern were cumulative effects of both the generating station and mining operations on regional air quality, greenhouse gas emissions on a regional and national basis, and effects on groundwater resources underlying Black Mesa. As noted previously, many scoping participants wanted the effects of historic mining and groundwater withdrawals to be carefully and accurately considered in the cumulative effects analysis of this EIS. Other comments focused on the effects of current and future mining and groundwater withdrawals on future opportunities for community development on both the Navajo Nation and the Hopi Tribe.

Public scoping comments were synthesized into EIS issues to be addressed in each EIS chapter, and by resource topic (e.g., Air Quality, Water Resources). **Table 1-12** summarizes public scoping comments on the Proposed Action; alternatives that should be considered; and suggestions for the future operations of the NGS and the proposed KMC. **Table 1-13** provides a list of issues by resource, and identifies where the issue is addressed in the document.

1.12 Document Organization

The remainder of the EIS is organized into the following chapters.

Chapter 2.0 – This chapter provides a summary of the alternatives considered but eliminated, and the process that was implemented to develop action alternatives that are evaluated in the EIS. The Proposed Action, three action alternatives, and No Action Alternative are described in detail. A summary table is provided at the end of Chapter 2.0 to identify, by resource, the major characteristics of each alternative and summarize each alternative's impacts in a comparative format.

Chapter 3.0 – The introduction to Chapter 3 presents background information that is applicable across all resources and alternatives. This chapter is divided into sections specific to the environmental, social, and economic resources and conditions relevant to the project area. Each section briefly describes the "affected environment" for that resource, followed by a description of the direct, indirect, and cumulative impacts that are anticipated to result to that resource from implementation of the Proposed Action, three action alternatives, and No Action Alternative. The chapter introduction describes the organizational format that follows for each resource and provides background information regarding the methodology used in evaluating impacts described in the EIS.

Chapter 4.0 – This chapter summarizes by resource the measures that have been recommended for consideration to mitigate (avoid, reduce, or otherwise offset) impacts that have been identified in Chapter 3.0.

Chapter 5.0 – This chapter presents a discussion of the relationship between short-term uses of man's environment and maintenance and enhancement of long-term productivity.

Chapter 6.0 – This chapter identifies the irretrievable resources that would be lost and irreversible impacts that would occur, as a result of implementing the Proposed Action, the three action alternatives, and No Action Alternative. Irretrievable commitments apply primarily to the use of nonrenewable resources that cannot be replenished such as fossil fuels, paleontological and cultural resources. Irreversible commitments primarily result from the use or loss of a specific resource that cannot be replaced within a reasonable time.

Chapter 7.0 – This chapter describes the elements of consultation and coordination performed by the federal agencies during the development of this EIS. Topics include interaction with cooperating agencies, government-to-government consultation, and resource subgroup activities.

Chapter 8.0 – This chapter identifies the Preparers of this EIS.

Table 1-12 Public Scoping Comments on the Proposed Action and Alternatives Development

Topic	Affected Facility		Scoping Comment Summary
	NGS	Proposed KMC	
Proposed Action – NGS	X		The current operations continue at the NGS through 2019 in terms of coal delivery, storage, and power plant combustion; air pollution controls; make-up water supply and use; industrial chemical delivery and storage; fly and bottom ash disposal and sales; solid and liquid waste generation and disposal; and power plant employment. The future operational changes at the NGS (2020-2044) related to installation of new air pollution controls and resulting air emissions; industrial chemical delivery, storage, and use; make-up water use and disposal; ash disposal and sales; power plant employment. Decommissioning and removal of any facilities resulting from retirement of generation units. Ongoing regulatory compliance by current NGS operations for stack emissions, water supply, surface water and groundwater quality, and waste management. Environmental protection activities and compliance plans for future activities extending from 2020-2044.
Proposed Action – Kayenta Mine and Proposed KMC		X	The current operations continue at the Kayenta Mine through 2019 in terms of surface coal mining locations, methods, and coal volumes produced; status of land disturbance and reclamation; mine haul road systems and maintenance; coal conveyor and railroad loadout systems; soil and overburden management; revegetation programs and monitoring; alternative water supply for mine uses; fugitive dust controls; surface water runoff controls and maintenance; livestock grazing management; mine employment; bond requirements and release. The future operations at the proposed KMC permit area (2020-2044) related to the same topics described for current operations. Specific issues include incorporation of shared facilities into a new administrative boundary and realignment of a segment of Navajo Route 41 and maintenance. Ongoing regulatory compliance by current Kayenta Mine operations for air quality, water supply, surface water and groundwater quality, and waste management. Environmental protection activities and compliance plans for proposed KMC activities extending from 2020-2044.
Alternatives – development process	X	X	How EIS alternatives were developed and screened. How the tribes were involved in the development of project alternatives via government-to-government consultation. Application of alternatives screening factors: the future cost of electrical power for CAP pumping; capability to generate surplus power for the Lower Colorado River Basin Development Fund; transmission infrastructure limitations; grid interconnection opportunities.
Alternatives – different electrical power sources	X	X	Consider lower carbon dioxide emitting fossil-fuel or other sources (natural gas, nuclear) and renewable energy sources (wind, solar, hydroelectric). Renewable energy project locations were suggested on Navajo Nation, Hopi Tribe, Pascua Yaqui Tribe, and Gila River Indian Community reservation lands. Consider a full or partial NGS federal share replacement alternative that places a renewable energy project on reclaimed Black Mesa and Kayenta Mine lands as specified in the OSMRE settlement agreement. Consider the use of municipal waste sources as an alternative source of power for CAP.

Table 1-12 Public Scoping Comments on the Proposed Action and Alternatives Development

Topic	Affected Facility: NGS	Affected Facility: Proposed KMC	Scoping Comment Summary
Alternatives – emissions controls	X	X	Consider clean coal technologies; opportunities for underground sequestration of carbon dioxide; immediate shut down of two units, with one unit remaining.
NGS Alternatives – Conservation	X		Consider Smart Grid technology to reduce power generation demand at NGS.
Facilities and permit boundary		X	Consider an alternative that includes only former Black Mesa Mine support facilities without expanding the proposed KMC boundary; consider an alternative that involves no addition of former Black Mesa Mine support facilities or lease area to the proposed KMC.
Future mining on Hopi lands		X	Consider an alternative that would avoid or limit coal mining on Hopi Reservation surface to protect cultural resources.
Mine water sources		X	Consider alternatives to obtain mine water from the C and D aquifers, or other surface water and groundwater sources, with a consequent reduction in withdrawals from the N-Aquifer.
No Action – potential replacement power sources	X	X	Possible purchase agreements/new sources of electrical power that could be acquired by the NGS owners and the Central Arizona Water Conservation District in the event that the NGS ceases to operate. Consider the opportunities for the complete replacement of the NGS with renewable energy power generation.
No Action – alternative coal markets		X	Consider any reasonable alternatives for exporting Kayenta Mine coal.

Table 1-13 Public Scoping Resource Issues Addressed in the EIS

Affected Facility			Impact Issue	EIS Section Where Addressed
NGS	Proposed KMC	WTS/STS		
Air Quality				
X	X		Impacts of criteria and hazardous air pollutants from power plant stack emissions, other combustion sources, and fugitive dust on local and regional air quality and consequent (indirect) impacts on ecological systems and human communities.	1.7.1.3.1, 3.1.1.2, 3.1.4.2.1, 3.1.4.3.1.1
X			Impacts of power plant stack emissions on formation of regional haze and the indirect effects on air quality related values (visibility in Class I and Class II areas).	3.1.4.3.1, 3.1.4.3.5
Climate Change				
X	X		Impacts of project greenhouse gas emissions on local and regional climate and air quality, and the consequent impacts on surface water and groundwater resources, ecological systems, and human land uses.	3.2.4.1
Landforms and Geology, Mineral Resources, Paleontology				
X	X		Impacts to scientifically valuable paleontological resources located in project areas proposed for surface disturbance.	3.5.4.5.2
	X		Impacts on geology and mineral resources from mining activities.	3.3.4.3.2, 3.4.4.3.2
Water Resources				
X			Impacts on water quality from coal ash constituent migration into aquifers underlying the NGS.	3.7.4.2.1.1
	X		Impacts of N-Aquifer drawdown by mine water supply wells and other groundwater withdrawals, on local and regional spring and stream flows; and water quality in relation to human and wildlife use areas.	3.7.4.2.2.1
	X		Impacts of N-Aquifer drawdown by mine water supply wells and other groundwater withdrawals on subsidence and sinkhole creation.	3.3.4.3.2.2, 3.7.4.2.5.3
	X		Impacts of surface runoff sediment from mined areas on water quantity and quality in stormwater detention ponds and downstream drainages used for livestock and other human uses.	3.6.4.6.2.1, 3.7.4.2.2.6
	X		Alternative water supply options (other than the N-Aquifer) for dust suppression and other consumptive uses at the mine.	3.7.4.2.2.2
Biological Resources				
X	X	X	Impacts on quantity and quality of soils removed and stored during surface disturbance activities and the subsequent vegetation cover and diversity in revegetated areas used by wildlife. Impacts of non-	3.8.4.3.2.1, 3.9.4.1.2.1

Table 1-13 Public Scoping Resource Issues Addressed in the EIS

Affected Facility			Impact Issue	EIS Section Where Addressed
NGS	Proposed KMC	WTS/STS		
			native plant invasion into revegetated areas and natural communities.	
X	X	X	Impacts on the quantity and quality of wildlife habitat removed by disturbance of natural communities and on wildlife populations displaced by surface disturbance, human activity, and noise.	3.10.4.3.2.1
	X		Impacts to plant and animal individuals and populations (including special status species) from decreased flows from springs and streams affected by mine groundwater drawdown.	3.10.4.3.2.2
X	X		Impacts on aquatic and terrestrial species (including special status species) reproduction and growth from exposure to trace metals and other pollutants through inhalation and food chain bio-concentration.	3.10.4.3.2.3, 3.12.4.3.1.1, 3.13.4.4.1.1
Land Use, Transportation, Grazing, Residential Uses, Recreation, Visual Resources				
	X		Impacts of relocations on local residents displaced by expanded mining and compensation for relocation.	3.14.4.3.2.1
	X		Impacts of active mine activities (clearing, blasting, coal hauling, dewatering) on local land uses (livestock grazing and water sources, human water sources, traditional plant gathering).	3.14.4.3.2.1
X	X		Impacts of particulate emissions and other constituents of regional haze on viewsheds in the vicinity of the project.	3.14.4.3.1.2
	X		Impacts of airport lighting on night skies observed from Black Mesa.	1.7.2.1.6, 3.10.4.3.1.2
Public Health and Safety				
	X		Impacts on human health from identified potential hazards from industrial activities (electromagnetic radiation, power pole preservatives, dust suppressants, coal seam fires, periodic mine overburden blasting). Impacts on human health from burning coal for indoor heating.	3.15.4.3.2.2, 3.15.4.3.3.2
X	X		Impacts on human health, growth, and reproduction from exposure to emitted trace metals and other pollutants from inhalation and food chain bio-concentration. Sources of exposure include soil, water, wild and garden vegetation, wild game, and livestock.	3.16.5.3.1, 3.16.5.3.2
Cultural Resources, Community Values, and Traditional Knowledge				
X	X	X	Impacts of construction activities and mining on cultural resource sites, artifacts, and human burials.	3.17.4.3.2
	X		Impacts to the traditional cultural values and sacred sites (including springs) that are associated with the Black Mesa and how these values will be addressed	3.17.3.3.4

Table 1-13 Public Scoping Resource Issues Addressed in the EIS

Affected Facility			Impact Issue	EIS Section Where Addressed
NGS	Proposed KMC	WTS/STS		
			in mining and reclamation.	
	X		Impacts to tribal members living traditional life styles who must engage with PWCC and federal agencies on land use (home sites, grazing, water supplies, traditional use plant gathering) and reclamation decisions.	3.17.3.4
X	X		Impacts of project activities in relation to the Fundamental Laws of the Diné.	3.18.3.1.6.2, 3.18.3.1.6.3
Social and Economic Conditions				
X	X		Impacts on PWCC and NGS owner revenues and costs from current and future operations based on Kayenta Mine coal volume and production costs, and the production costs of coal-fired electrical generation at the NGS.	3.18.4.3.1.2, 3.18.4.3.2.2
X	X		Impacts of the current and future financial contributions of coal mining and electrical generation (royalties permit and lease fees, payments to communities) to the Navajo Nation and Hopi Tribe.	3.18.4.3.6.3
X	X		Impacts of Tribal member hiring practices on current and future power plant and mine hiring of Navajo and Hopi, and impacts of power plant and mine operations on regional employment and wages.	3.18.4.3.6.1
X	X		Impacts of ongoing demographic, economic, attitudes, and social organization trends in Navajo and Hopi populations, including trends in local crime and law enforcement capability, and trends in community physical and mental health. Impacts to the social fabric and values that provide incentives for younger tribal members to remain on the Reservation.	3.18.4.3.6.2
X	X		Impacts of current and future costs of power required for CAP pumps. Economic impacts if there are reductions in surplus revenues for the Development fund, and funding for Indian water settlements.	3.18.4.3.6.5
X			Impacts of the social cost of carbon in accordance with federal agency guidance.	3.2.4.2.4
X			Impacts of trading power plant pollution reduction credits by Tribes or power plant owners.	1.8.1

Table 1-13 Public Scoping Resource Issues Addressed in the EIS

Affected Facility				
NGS	**Proposed KMC**	**WTS/STS**	**Impact Issue**	**EIS Section Where Addressed**
Environmental Justice				
X	X		Impacts expressed as disproportionately high adverse human health and environmental effects of federal programs, policies and activities on minority populations. Concerns on this topic include: extraction of groundwater for industrial uses rather than local community uses; disproportionate environmental and social impacts for tribal members living in the vicinity of the Kayenta Mine who desire to live a traditional life style, or believe that economic benefits are not fairly shared; disproportionately high economic benefits to the CAP tribes that receive power from the NGS compared to tribal members living where mining and electrical generation occur.	3.18.4.3.1, 3.18.4.3.2, 3.19.4.3.1, 3.19.4.3.2

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Chapter 2.0

Proposed Action and Alternatives

Acronyms and Abbreviations

1969 Lease	Navajo Project Indenture of Lease
BART	Best Available Retrofit Technology
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BM&LP Railroad	Black Mesa & Lake Powell Railroad
BO	Biological Opinion
CAP	Central Arizona Project
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CO_2	carbon dioxide
Co-tenants	Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
Development Fund	Lower Colorado River Basin Development Fund
EIS	Environmental Impact Statement
ERA	Ecological Risk Assessment
ESA	Endangered Species Act of 1973
HHRA	Human Health Risk Assessment
km	kilometer
KMC	Kayenta Mine Complex
kV	kilovolt
kW	kilowatt
LOM	Life-of-Mine
MW	megawatt
N-Aquifer	Navajo Aquifer
NEPA	National Environmental Policy Act of 1969, as amended
NGS	Navajo Generating Station
NGS Participants	U.S. (Reclamation), Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
NHPA	National Historic Preservation Act
NNEPA	Navajo Nation Environmental Protection Agency
NO_2	nitrogen dioxide
NO_X	nitrogen oxide
OSMRE	Office of Surface Mining Reclamation and Enforcement
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 microns or less
PFR	Partial Federal Replacement
PWCC	Peabody Western Coal Company
Reclamation	U.S. Bureau of Reclamation
ROW	Right-of-way

SO_2	sulfur dioxide
SRP	Salt River Project Agricultural Improvement and Power District
STS	Southern Transmission System
tpy	tpy
U.S.	United States
USEPA	U.S. Environmental Protection Agency
WTS	Western Transmission System

Contents

2.0 Proposed Action and Alternatives 2-1
2.1 Introduction 2-1
2.2 Formulation of Alternatives and Alternatives Eliminated from Further Consideration 2-2
2.2.1 Power and Generation Alternatives 2-2
2.2.2 Existing Project Component Alternatives 2-4
2.2.3 Federal Replacement Power Alternatives 2-7
2.2.3.1 Inventory of Project Concepts and Proposals 2-7
2.2.3.2 Technical Screening Criteria 2-8
2.2.3.3 Total Federal Replacement 2-10
2.2.3.4 Partial Federal Replacement 2-11
2.3 Alternatives Evaluated in Detail 2-13
2.3.1 Proposed Action 2-13
2.3.1.1 Navajo Generating Station 2-13
2.3.1.2 Proposed Kayenta Mine Complex 2-19
2.3.1.3 Transmission Systems and Communication Sites 2-24
2.3.1.4 Community Assistance and Environmental Measures 2-24
2.3.2 Partial Federal Replacement Alternatives 2-28
2.3.2.1 Natural Gas PFR Alternative 2-28
2.3.2.2 Renewable PFR Alternative 2-31
2.3.2.3 Tribal PFR Alternative 2-34
2.3.3 No Action 2-38
2.3.3.1 Navajo Generating Station 2-38
2.3.3.2 Proposed Kayenta Mine Complex 2-39
2.3.3.3 Transmission Systems and Communication Sites 2-39
2.3.3.4 Central Arizona Project 2-40
2.3.4 Impact Summary 2-42
2.4 References 2-63

List of Appendices

Appendix 2A - NGS Federal Share Replacement Alternatives Characterization

List of Tables

Table 2-1 Alternative Power and Generation Sources Considered for Full Replacement 2-2
Table 2-2 Alternatives Considered for the Major Proposed Action Components 2-4
Table 2-3 Technical Screening Criteria 2-8
Table 2-4 Characteristics of the 3-Unit Operation and 2-Unit Operation for the Proposed Action 2-14
Table 2-5 Schedule for Coal Mining by Coal Resource Area 2-19
Table 2-6 Proposed Production by Coal Resource Area 2020 through 2044 (based on 3-Unit Operation) 2-21
Table 2-7 Proposed KMC Activities – 2020-2044 2-21
Table 2-8 Annual NGS Proposed Action and Natural Gas PFR Energy Output 2-29
Table 2-9 Regional Employment Associated with NGS under the Natural Gas PFR Alternative 2-30
Table 2-10 Annual Coal Mined for NGS Under the Natural Gas PFR Alternative 2-30
Table 2-11 Regional Employment Associated with the Proposed Kayenta Mine Complex Under the Natural Gas PFR Alternative 2-31
Table 2-12 Annual Energy Output for the Proposed Action and Renewable PFR Alternative 2-32
Table 2-13 Regional Employment Associated with NGS Under the Renewable PFR Alternative 2-33
Table 2-14 Annual Coal Mined for NGS Under the Renewable PFR Alternative 2-33
Table 2-15 Regional Employment Associated with the Proposed KMC Under the Renewable PFR Alternative 2-34
Table 2-16 Annual Energy Output for the Tribal PFR Alternative 2-36
Table 2-17 Regional Employment Associated with NGS Under the Tribal PFR Alternative 2-37
Table 2-18 Annual Coal Mined for NGS Under for the Tribal PFR Alternative 2-37
Table 2-19 Regional Employment Associated with the Proposed KMC Under the Tribal PFR Alternative 2-38
Table 2-20 Assumptions for 350 MW Combined Cycle Natural Gas Turbine Facility Land Requirements, Permitting, and Construction 2-41
Table 2-21 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary 2-43

List of Figures

Figure 2-1 Proposed KMC Planned Mining Areas from 2020 through 2044 2-20

2.0 Proposed Action and Alternatives

2.1 Introduction

The purpose of this chapter is to identify and describe the alternatives that are evaluated in detail in Chapter 3.0 of the Environmental Impact Statement (EIS). The Proposed Action, referred to as the Navajo Generating Station (NGS)-Kayenta Mine Complex (KMC) Project, and three action alternatives are described in detail. A No Action Alternative also is described, which represents what is reasonably expected to occur if federal approvals, that are necessary to implement the Proposed Action, are not granted. These descriptions form the basis for comparing the environmental impacts, anticipated to occur with implementation of each of the alternatives, against one another in Chapter 3.0.

In accordance with the National Environmental Policy Act of 1969, as amended (NEPA), the EIS must "[r]igorously explore and objectively evaluate all reasonable alternatives, and for alternatives which were eliminated from detailed study, briefly discuss the reasons for their having been eliminated" (40 Code of Federal Regulations [CFR] Part 1502.14(a)). It also must consider reasonable alternatives that are not within the jurisdiction of the lead agency (40 CFR Part 1502.14(c)). NEPA regulations specifically direct the federal agency to "[s]tudy, develop, and describe alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources" (40 CFR Part 1507.2(d)).

As outlined in Section 1.5.1, the purpose and need for the Proposed Action is:

> To secure, after 2019, a continuously available and reliable source of power and energy to operate the CAP pumps, which would be competitively priced with NGS and could be sold as surplus power to generate revenues for deposit to the Development Fund, and to satisfy the purposes of the Arizona Water Settlements Act

This purpose and need statement was revised from the statement in the Notice of Intent published in the *Federal Register* on May 16, 2014 (79 Federal Register 28546) announcing the United States (U.S.) Bureau of Reclamation's (Reclamation's) intent to prepare an EIS for the NGS- KMC Project. The refinement to include the need for a competitively priced source of power and energy as part of the purpose and need was made as a result of comments received during the scoping process.

In this chapter, Section 2.2 provides a summary of the steps taken to explore and evaluate potential reasonable alternatives, including alternatives not within Reclamation's jurisdiction. The process by which potential alternatives were considered, dismissed from further evaluation, or carried forward in the EIS is described. A more detailed explanation of the process through which alternatives were considered and eliminated from further evaluation in the EIS is provided in **Appendix 2A**. Section 2.2.1 addresses potential alternative energy sources to coal-fired generation, which could replace the federal share of power generated by the NGS. Section 2.2.2 provides a short explanation as to why alternatives to existing NGS- and Kayenta Mine-related infrastructure components were not considered to be reasonable. Section 2.2.3 focuses on the process by which alternatives to the federal share of NGS power and energy were considered.

Section 2.3 provides a description of the alternatives evaluated in detail in Chapter 3.0: the Proposed Action (Section 2.3.1); three Partial Federal Replacement (PFR) alternatives (Section 2.3.2); and the No Action Alternative (Section 2.3.3). All the facilities included in the Proposed Action are presently in operation and are anticipated to continue operations through 2019. To provide context and background for descriptions of the Proposed Action and alternatives, ongoing NGS and Kayenta Mine operations (through the end of the lease term on December 22, 2019) are described in Section 1.7, Historical

Operations of NGS and Kayenta Mine. In Chapters 2.0 and 3.0, activities associated with the Proposed Action and alternatives during the period from 2020 through 2044, plus decommissioning, are described.

2.2 Formulation of Alternatives and Alternatives Eliminated from Further Consideration

2.2.1 Power and Generation Alternatives

To ensure full consideration of all reasonable alternatives that could meet the purpose and need for the Proposed Action, Reclamation investigated the practicability of replacing the NGS in its entirety with power generation facilities that would emit less carbon than coal ("lower-emitting sources"). None were carried forward for further analysis. **Table 2-1** identifies the facilities evaluated, and the basis for each alternative facility's elimination from further consideration. A full replacement alternative that utilizes renewable sources (wind, solar) was not considered in detail because the continuously available and reliable criteria included in the Purpose and Need could not be met without substantial backup power (e.g., natural gas combined cycle generation). This combination of generation sources would not be competitive with NGS (Section 2.2.3.1, Total Replacement).

Table 2-1 Alternative Power and Generation Sources Considered for Full Replacement

Source	Rationale For Dismissal
Retrofit NGS to Natural Gas	Background. This alternative would substitute natural gas for coal as a fuel source at NGS, requiring a retrofit of the boilers that generate steam, and providing a natural gas supply, which does not currently exist. The existing boilers are incompatible with natural gas. A retrofit would be difficult to accomplish on-site while keeping the NGS operational during the interim. Moreover, natural gas supplies do not exist in the vicinity of NGS; a 20-inch gas transmission line approximately 135 miles in length would need to be constructed at an estimated cost of $3.1 million per mile (Interstate Natural Gas Association of America 2014). Retrofitting the NGS to a natural gas facility is not carried forward in the EIS because the capital and operating costs would significantly reduce opportunities to generate and market surplus power thus not meeting the purpose and need. In addition, non-federal NGS Participants have indicated that retrofitting is not economically justifiable compared to building a new gas-fired generating plant in a different location, which is the equivalent of the No Action Alternative.
Hydropower/pumped storage	Background. This alternative would substitute electricity generated by hydropower units for electricity generated by coal at NGS. Central Arizona Water Conservation District currently holds a contractual allocation to 161.6 MW and 182,235 MWh of hydropower capacity from Hoover Dam, which is used to provide ramping, reserves, and regulation power of the CAP. All current supplies of hydropower from Hoover Dam are fully appropriated. Current Hoover Dam contracts expire in September 2017. Central Arizona Water Conservation District's new post 2017 contract share of Hoover Dam energy will be reduced to 171,422.3 MWh, while its capacity allocation will remain unchanged.[1] The CAP system includes pumped storage hydropower generating capacity at Lake Pleasant, where water is stored in the fall, winter, and spring when power rates are

[1] Declining water levels in Lake Mead due to ongoing drought have already reduced Central Arizona Water Conservation District's delivered capacity from Hoover Dam by 25 percent, and Lake Mead water levels are projected to continue to decline over the near term, resulting in further capacity and energy reductions.

Table 2-1 Alternative Power and Generation Sources Considered for Full Replacement

Source	Rationale For Dismissal
	lower, and then released during summer when the Lake Pleasant power plant is able to generate hydropower during periods of peak power demand. This process does not result in any net power generation increase. No other pumped storage opportunities exist on the CAP system that could provide sufficient quantities of power to operate all or even a portion of the CAP pumps. Hydropower/pumped storage alternatives are not carried forward in the EIS because this technology does not meet the purpose and need; it is not technically feasible given the current available hydropower generating capacity.
Nuclear	Background. This alternative would substitute electricity generated from a regional nuclear power plant for electricity generated by coal at NGS. There is limited power available from the existing Palo Verde Nuclear Generating Station near Phoenix following plans by Public Service of New Mexico to use power from Palo Verde to replace capacity being lost at the San Juan Generating Station. Plans to build a fourth unit have not progressed; therefore additional capacity will not be available in the near future. Nuclear generation is not carried forward in the EIS because of the current limitations for available nuclear generating capacity and time required to bring additional capacity on-line.
Biomass	Background. This alternative would substitute electricity, generated from a biomass fuel (most likely solid waste, or biomass crops) burned at a separate generation facility, for electricity generated by coal at NGS. Current biomass generation technology generally is suited to a partial replacement alternative. Wood, agricultural, manufacturing waste and diverted municipal solid waste are the most common fuels for biomass generation. Transportation costs, cooling water needs, air quality concerns, and relatively high cost of produced energy result in biomass not being economically competitive even though municipal solid waste volumes in the Phoenix metropolitan area could be adequate to support a facility (National Renewable Energy Laboratory 2012). Moreover, legal arrangements to access waste streams and siting challenges raise concerns of the ability to be operational by 2025.[2] Biomass is not carried forward in the EIS because it does not meet the purpose and need and is not considered technically feasible given the time to bring a biomass unit on-line.
Conservation	Background. This alternative would include electrical use reduction measures that would be equivalent to the electricity generated by coal at NGS. Conservation is a demand-side management approach. The year-round industrial pumping loads associated with CAP offer limited opportunity for conservation beyond that which Central Arizona Water Conservation District already achieves through operational optimization. Complete elimination of pumping demand is not feasible and the prospective gains in efficiency do not support the capital investment required to replace existing pumps with different technology. Conservation is not carried forward in the EIS because this option does not meet the purpose and need and is not technically feasible.

[2] The year 2025 was considered to be an adequate timeframe for construction of a new project subsequent to an expected Record of Decision.

2.2.2 Existing Project Component Alternatives

This analysis also considered alternatives that could potentially replace or modify major components associated with the NGS and proposed KMC and reduce environmental impacts. All of the major infrastructure components associated with the NGS and proposed KMC are in place and operational, representing substantial in-place capital investment that has been largely amortized. In general, the economic costs and lack of any technical or environmental advantage associated with replacing these components resulted in no alternatives being carried forward. **Table 2-2** identifies the rationale for eliminating component alternatives from further consideration.

Table 2-2 Alternatives Considered for the Major Proposed Action Components

Component	Rationale For Dismissal
Transmission Systems and Communications Sites	Description. This alternative would provide a different or modified transmission system to deliver electricity from NGS to CAP. Present day transmission system design and construction techniques do not offer operation, maintenance, or environmental benefits to offset the additional construction, costs, land disturbance, and visual impacts that would result from decommissioning and replacement of the existing facilities. Communication sites currently are located on the most favorable terrain for communication purposes. Many of the NGS communication sites are co-located with communication sites that are owned and operated by others and thus relocating the NGS-related facilities could result in additional communication sites across the landscape. Substantive issues or complaints have not been raised regarding existing sites and overriding benefits from relocating sites to other locations have not been identified. No replacement transmission systems or communication facilities alternatives are carried forward in the EIS because replacement of the transmission systems or communication facilities do not offer lower impacts to the environment over the Proposed Action.
Black Mesa & Lake Powell (BM&LP) Railroad	Description. This alternative would provide a different or modified coal delivery system from the Proposed Kayenta Mine Complex to NGS. Contemporary railroad design and construction do not offer sufficient advantages over the existing facility with respect to siting, efficiency, or long-term environmental effects, which would warrant replacement of the historical operation. Replacement of electric locomotives with diesel would result in higher cost of operation (diesel fuel, fuel delivery, fuel storage, and fueling system) and incur costs to remove the existing railway system. The existing system is tied into the NGS power supply. Use of diesel-fueled locomotives would increase emissions along the right-of-way (ROW) from the historical operations. Replacing rail haul with truck haul would not be economically efficient. Truck haul would require a fleet of more than 100 semi-trucks and several hundred drivers, fleet maintenance and administrative staff. Coal transportation costs would be substantially higher as a result of the capital investment in tractors and trailers, outlays for fuel, tires and other parts and supplies, and staff expense. It also would result in substantially more traffic on highways (the existing rail is in a separate ROW). No coal transport alternatives to the BM&LP Railroad are carried forward in the EIS because replacement of the existing rail system does not offer lower impacts to the environment in terms of air quality and public safety over the Proposed Action.
New Coal Supply/Mine	Description. This alternative would provide a new coal source for use by NGS. Providing coal from a coal supply other than Peabody Western Coal Company's (PWCC's) Kayenta Mine is not feasible. There are no other active coal mines with

Table 2-2 Alternatives Considered for the Major Proposed Action Components

Component	Rationale For Dismissal
	suitable coal within a reasonable distance to transport the coal. Nor is there a transportation network available to transport the coal, in a safe and more environmentally sound manner than current practice, from more distant sources in New Mexico or Colorado. It would not be feasible to identify and develop a new coal source in a timely manner that meets the NGS plant operational specifications, even if one was available. The environmental impacts from developing a new mine would likely be equal to or more substantial than those already resulting from current operations at the Kayenta Mine. Nor is it reasonable to anticipate that an entity would invest in developing a new coal source for a generation plant that is intended to cease operation in 2044. No coal supply alternatives are carried forward in the EIS because replacement of the existing mining operation with an alternative coal source does not meet the OSMRE Purpose and Need does not offer lower impacts to the environment over the Proposed Action; and may not be technically or economically feasible within the timing constraints.
Limited incorporation of former Black Mesa Mine support facilities, that are used for mining operations, into the Kayenta Mine permit area	Description. Instead of incorporating the entire former Black Mesa Mine lease area, this alternative would include the Kayenta Mine plus the 566 acres associated with support facilities that are located in the former Black Mesa Mine area that are used by the Kayenta Mine operations. This alternative has the same environmental impacts as the Proposed Action because the mine plan would not change. This alternative would not result in less environmental impacts than the Proposed Action. Mining and other land-disturbing activities anywhere on the mine leasehold would continue to be subject to review pursuant to NEPA, whether incorporated into the proposed KMC under this Proposed Action or evaluated under a separate NEPA process. However, this alternative would not allow for timely minor repairs to address operation, maintenance or other unplanned unsatisfactory environmental or safety conditions that occur within the entire mine leasehold, or arise from weather-related or other natural events. Required access and response action approvals for minor land-disturbing activities located outside the permanent permit boundary require time-consuming administrative steps that are not required for similar actions within the permanent permit boundary. Thus, this alternative would allow potentially unsafe and unsatisfactory environmental conditions to persist and be left unattended for extended periods of time. This alternative was eliminated from further evaluation.
No mining on Hopi Tribe surface (J-21W) to protect cultural resources.	Description. No surface disturbing activities would be allowed on J-21W to insure protection of cultural resources. Coal that would otherwise be mined on J-21W would be mined within other coal resource areas on the KMC. This alternative could be implemented by changing the PWCC Life of Mine Plan currently under review by OSMRE. Approximately 46 million tons of coal would be mined from J-21W from 2024 through 2044 (Table 2-6), which represents slightly less than ½ the total coal that would be mined from all three joint coal resource areas (J-19, J-21, and J-21W) (Figure 2-1). While not quantifiable, it is likely that Hopi would receive lower shared revenue if J-21W were not mined, and new or expanded mining was relocated onto Navajo or other Joint Use surface. Cultural resources potentially present on J-21W are currently under investigation, and more specific information will be available within the time frame of this EIS. Through implementation of the KMC Programmatic Agreement and subsequent treatment plans, there would be opportunities to avoid cultural resources while allowing surface coal mining to occur. In summary, a mining prohibition on J-21W could potentially reduce the long-term economic benefits to the Hopi Tribe, and it would be premature to limit future development before cultural resource values are fully disclosed, and considered by the members of the Hopi Tribe. Because of these uncertainties and

Table 2-2 Alternatives Considered for the Major Proposed Action Components

Component	Rationale For Dismissal
	risks, this alternative was not further developed for analysis.
Water Supply/Kayenta Mine	Description. This alternative would substitute D-Aquifer groundwater for N-Aquifer groundwater for Kayenta Mine industrial and potable uses. Based on groundwater modeling results and other analyses, the D-Aquifer underlying the proposed KMC was determined to be of insufficient quantity and quality to replace the total water withdrawn from the N-Aquifer for mine and potable water use. In addition, economic considerations preclude installation of necessary infrastructure to pump water from the D-Aquifer for dust suppression only. Further justification for this conclusion was previously provided in Office of Surface Mining Reclamation and Enforcement (OSMRE) environmental reviews (OSMRE 2011, 2008), and also in the water resources section (see Section 3.7.4.2 of this EIS). No mine water supply alternatives are carried forward in the EIS because replacement of the water source is not economically feasible and would not provide an adequate supply.
Cooling water/NGS	Description. This alternative would substitute another cooling water source for surface water from Lake Powell There are no other sources of surface water available for use at NGS. Pumping groundwater from the N-Aquifer, while possible, is not considered to be reasonable because of the great depth to groundwater at this location, There are no existing water supply wells developed in this source and NGS annual water requirements (up to 40,000 acre feet per year) would exceed the sustainable aquifer yield. Use of Lake Powell water would result in withdrawal of relatively small water volumes as compared to the total capacity of this large reservoir, and all pumping facilities and pipelines are already in place. No NGS cooling water alternatives are carried forward in the EIS because a different water source is not economically feasible and use of the N-Aquifer would be unsustainable as compared to Lake Powell, which is a renewable source.
Clean Coal Technology (Coal Gasification and Carbon Sequestration)	Description. Clean coal technologies are centered around pre-combustion controls (creation of synfuels, such as hydrogen), and post-combustion controls (carbon dioxide sequestration) that involve underground injection, or carbon dioxide capture and conversion to a solid carbonate http://energy.gov/fe/science-innovation/clean-coal-research, http://saskpowerccs.com/ccs-projects/boundary-dam-carbon-capture-project/. Pre-combustion controls would require construction of a separate coal synfuels facility. The resulting fuels (gas, liquids) are not compatible with NGS coal combustion operations, which would require a major retrofit (see Table 2-1 Retrofit to Natural Gas). Demonstration synfuel projects have been developed, but commercial scale projects such as NextGen 2.0 requiring federal funding support have been discontinued. An investment in pre-combustion coal technology would not meet the purpose and need because of the immaturity of the technology, and construction and operation costs that are not competitive with those of NGS. Carbon dioxide capture and storage is a developing technology that has not been applied at a scale comparable to the output from NGS. The 2,475 MW W.A. Parish Plant in Texas is being retrofitted to capture the carbon dioxide from a 240 MW unit. Approximately 90 percent of the emitted carbon dioxide is captured by an amine absorption process, and then injected into a nearby oil field for enhanced oil recovery. https://www.globalccsinstitute.com/projects/petra-nova-carbon-capture-project (Global Carbon Capture 2016). The W.A. Parish project is being partially supported by U.S. DOE grants, with a budget in excess of $1 billion. The enhanced

Table 2-2 Alternatives Considered for the Major Proposed Action Components

Component	Rationale For Dismissal
	oil recovery benefits associated with the W.A. Parish plant could not be replicated at NGS. The nearest enhanced oil recovery area to NGS would be in southeastern Utah, which would require a new pipeline to the vicinity of Aneth, Utah. Carbon sequestration would not meet the purpose and need because of very high capital and operation costs that are not competitive with NGS operations.
Retire two NGS units, and operate one.	Description. Two units at NGS would be taken out of service, and one would continue to operate after 2019. Decommissioning two units would result in a two-thirds reduction in power production, which would exceed the federal NGS share, and would not allow the other NGS participants to meet their obligations for power delivery, or to recover operating costs. This alternative would not meet the Reclamation purpose and need, and would infringe on the rights of the other participants.

2.2.3 Federal Replacement Power Alternatives

The Notice of Intent indicated that two alternatives were being considered for evaluation in the EIS: a PFR alternative and a total federal replacement alternative. The Notice of Intent also indicated that additional alternatives could be added for consideration following scoping and in response to Reclamation's further consideration of the purpose and need, of which none were identified.

Public interest expressed during scoping demonstrated strong support for Reclamation reducing its share of carbon dioxide emissions associated with supplying power to the CAP. Numerous comments received during scoping supported the study of potential EIS alternatives focused on replacing all or a portion of the federal share of power from NGS with power from sources that would reduce atmospheric emissions over those resulting from implementation of the Proposed Action. A majority of the scoping comments received regarding alternatives to the Proposed Action advocated use of renewable energy sources.

Incorporating public input received during scoping, Reclamation centered the alternatives development process on examining the replacement of federal share in NGS, total or in part, with lower-emitting sources. Reclamation adopted a stepwise approach that included research, assessment of technical viability, economic analysis and market factors, and alternatives formulation based on information from previous steps in the process. The remainder of this section describes the approach, outcomes, and ultimately the action alternatives developed for inclusion in the EIS.

2.2.3.1 Inventory of Project Concepts and Proposals

The first step in the alternatives development process was research. Working in conjunction with the National Renewable Energy Laboratory and AECOM, Reclamation developed an inventory of lower-emitting energy generation options (i.e., projects and proposals) identified as being under consideration for development in Arizona and nearby areas of surrounding states. The extensive inventory incorporated options from the following sources:

- Input from public scoping;
- The Bureau of Land Management's (BLM's) Solar Energy Plan and programmatic EIS for six southwestern states (BLM 2012);
- Print media and online resources including renewable energy trade information releases and announcements; and

- National Renewable Energy Laboratory's ongoing research on renewable energy, for example, the U.S. Department of Energy's SunShot Vision Study (U.S. Department of Energy 2012).

The inventory was comprised of 169 options as listed in **Appendix 2A, Attachment 2A-1.** The name, technology type, developer, estimated generation in megawatts (MW), and potential interconnection points for delivery to the CAP system are provided. Technology types identified in the inventory were solar, wind, hydropower, natural gas, biomass, nuclear, geothermal, and combinations of these technologies. This research established a foundation to conduct a technical analysis.

2.2.3.2 Technical Screening Criteria

The next step in the alternatives development process was to assess the technical viability of potential replacement options identified through the research phase. Technical screening criteria were established that all potential alternatives would need to meet to be considered reasonable alternatives for further analysis. In general, the screening criteria addressed essential technical requirements as established in the purpose and need, and practical implementation parameters such as timing and sizing. Those requirements include:

- Connecting to and optimizing the existing transmission system and infrastructure that deliver power to the CAP;
- Commercially proven technology, as demonstrated by at least one operating commercial scale facility in the U.S.;
- Providing competitively priced, reliable power on a continuous basis;
- Lower atmospheric emissions than NGS;
- Implementation by January 2025, which was considered an adequate timeframe following an expected Record of Decision to complete solicitation, procurement, authorization, permitting, construction, and amortization of the capital investment for a new project; and
- Sizing parameters based on federal share characteristics and operational constraints at NGS.

Table 2-3 depicts the screening criteria, thresholds or measurement units used for each criterion, and the basis or rationale for its inclusion in the technical assessment process.

Table 2-3 Technical Screening Criteria

Screening Level/Criteria	Thresholds or Measurement Units	Basis/Rationale for Inclusion
Level 1 – Technology and Consistency with EIS Purpose and Need		
1A. Capability to deliver electrical energy to CAP; to be competitively priced relative to NGS; and to facilitate the marketing of surplus power	Must be able to connect to existing transmission systems that currently deliver power to the CAP. Must optimize available infrastructure (capacity, transmission rights, and substations). Must demonstrate capital and operational costs similar to those of NGS.	Required by the EIS purpose and need.
1B. Commercially proven	Meets technical readiness thresholds established by National Renewable Energy Laboratory.	Must be existing proven, commercial–scale technology.

Table 2-3 Technical Screening Criteria

Screening Level/Criteria	Thresholds or Measurement Units	Basis/Rationale for Inclusion
1C. Reliable and continuously available	Must allow Central Arizona Water Conservation District to make water deliveries (via pumping) as scheduled.	Required by the EIS purpose and need.
1D. Lower-emitting source	Source must emit less atmospheric pollutants than would be emitted at NGS after Best Available Retrofit Technology (BART) compliance.	Based on the Notice of Intent, public scoping comments, and existing Technical Working Group federal commitments.
Level 2 – Timing		
2. Implementation timing	Must be implementable (operational) by 2025 (determined to be a reasonable period following the expected Record of Decision).	Adequate time to complete permitting and construction and allow for amortization of capital investment.
	Open market power purchases may be required between 2020 and 2025.	
Level 3 – Replacement of NGS Federal Share		
3A. Total replacement of NGS federal share	Must be compatible with Central Arizona Water Conservation District operations – minimum 3.0 terawatt hours to power CAP, with the ability to generate and market surplus energy.	The administration of the federal share in NGS falls under the jurisdiction and authority of the Department of the Interior.
3B. Partial replacement of NGS federal share	Capacity consistent with NGS operational curtailment range of the federal share: 25 MW to 309 MW.	The administration of the federal share in NGS falls under the jurisdiction and authority of the Department of the Interior.
	Must include own firming.[1]	NGS cannot be used as a firming source due to its operational constraints as baseload facility.
	Energy generated by the partial replacement is used to power CAP.	NGS continues to provide surplus energy.

[1] Firming refers to a secondary source of energy to compensate for the normal variability and irregularity of renewable energy generation (e.g., if part of a solar array is shaded by cloud cover) in order to assure delivery of a specific quantity of energy during a defined period of time.

Applying the screening criteria to the inventory resulted in 36 options passing all three levels; 14 were identified as total federal replacement options, and 22 were identified as PFR options. Technologies represented by the 36 options were solar, wind, natural gas, and a hybrid combining solar paired with natural gas. A detailed description of the screening process at all three levels is provided in **Appendix 2A**; summary results are provided in **Appendix 2A**, **Table 2A-4**.

The screening process demonstrated: 1) there are multiple opportunities for renewable and natural gas options over a wide geographic region that could provide NGS federal share replacement energy to the CAP; 2) the renewable energy market is still in a formative stage and is being driven more by meeting renewable portfolio objectives than by the potential profitability of new projects; 3) many recent renewable energy projects in the planning stage have been canceled because of a lack of commercial viability, and 4) the screening results provide insight into the generation technologies available and the scale of projects needed to meet NGS federal share replacement options.

Based on these insights and the uncertainties associated with the current and reasonably foreseeable energy market in Arizona, Reclamation concluded that it would be premature and impracticable to pursue specific options from the inventory as EIS alternatives because these proposed projects might not be optimal given future energy market uncertainties and potential changes in federal, tribal, and state energy policies and economic incentives. Reclamation also recognized that there are many combinations of technologies and project locations that could meet potential NGS federal share replacement needs. Reclamation anticipates that any arrangement to supply CAP power from a source other than the NGS would come about as a result of future procurement, competitive bidding and negotiation authorized by legislation, the specifics of which are unknown at this time. In conclusion, with respect to alternatives development, Reclamation considered the NEPA decisions that can be made in the near-term, versus decisions that are premature because of changing circumstances, speculation, or lack of essential information. While a range of NGS federal share replacement options can be established conceptually from available information within the time frame for the EIS, the actual project(s) that would provide replacement energy would be more concretely defined closer to implementation through the competitive process. The future NEPA evaluation of site-specific proposals, assuming power purchased through a power purchase agreement,[3] would allow a detailed and accurate review of effects on resources, economic benefits and costs. For these reasons, after the screening process was complete, Reclamation focused on the technology types identified through the screening rather than on specific projects, as described in the following sections.

2.2.3.3 Total Federal Replacement

The results of the screening process indicated that renewable (i.e., solar and wind) and natural gas technologies could supply enough energy for a replacement of the entire federal share of the NGS. Therefore, the next step in the alternatives development process was to further evaluate and differentiate between these suitable technologies; economic analysis based on the current and reasonably foreseeable energy market was recognized as the appropriate tool.

To address the “competitively priced” aspect of the project purpose and need, Reclamation enlisted the National Renewable Energy Laboratory as an experienced third party with internationally recognized expertise in the field, to conduct a series of three economic analyses. The first was a levelized cost of energy analysis, or total all-in price of generation per MW-hour (National Renewable Energy Laboratory 2015a). Levelized cost of energy provided a quantitative approach to assess which technology competed more favorably against another given reasonably foreseeable market conditions. The second analysis focused on prices at two particular locations – the Mead switchyard adjacent to Hoover Dam in southern Nevada, and the Palo Verde switchyard connected to the Palo Verde Nuclear Generating Station west of Phoenix, Arizona (National Renewable Energy Laboratory 2015b). These locations were selected for analysis because they are two of the most active wholesale power trading points in the Southwest with direct connection to CAP load and the California renewable energy market. This analysis also compared electricity prices at these two “trading hubs” to southern California contract prices to test whether the resale of power into the California market potentially could result in greater revenues. The third analysis provided projections of NGS future operating costs based on assumptions of future capital investments, lease and fuel costs (National Renewable Energy Laboratory 2015c).

The collective findings of these studies, and information from the National Renewable Energy Laboratory’s Annual Technology Baseline for 2015 (National Renewable Energy Laboratory 2015d), indicated that it would be difficult to recover capital costs for any new generation facility, whether selling into the Mead trading hub to southern California, or to one of the major utilities in Arizona. The National Renewable Energy Laboratory concluded a combination of abundant natural gas supplies and associated effects on natural gas prices and existing gas-fired generating capacity would likely keep spot

[3] A power purchase agreement is a contract between an electricity provider and customer through which the latter agrees to purchase energy and/or capacity under terms outlined in the contract (e.g., term, quality, and price).

market and short-term power purchase prices below the cost to justify construction of a new facility regardless of technology.

For example, the most cost-effective potential total federal replacement option in the inventory, a hybrid facility consisting of photovoltaic solar in conjunction with combined-cycle natural gas near McCullough substation in Boulder City, Nevada, yielded a levelized cost of energy range of $64 to $71 per MW-hour in 2020 (National Renewable Energy Laboratory 2015a). This is approximately 52 to 73 percent higher than the National Renewable Energy Laboratory's projected cost of production at the NGS in 2020 (i.e., $41 to $42 per MW-hour) (National Renewable Energy Laboratory 2015c). Based on CAP annual energy use of 2.7 terrawatt-hours, approximately $59 to $81 million would be added to the annual operating costs for Central Arizona Water Conservation District. The levelized cost of energy for the hybrid facility also exceeds the reasonably foreseeable market price of energy in 2020 at the Mead trading hub[4] by approximately 28 to 137 percent (National Renewable Energy Laboratory 2015b), substantially limiting the opportunities to generate revenues from the sale of surplus power. Sales of surplus power were projected to yield a net revenue of $21.9 million to the Lower Colorado River Basin Development Fund (Development Fund) in 2014, with net revenues of $22.7 million budgeted for 2015 (Central Arizona Water Conservation District 2013).

The above findings led Reclamation to conclude that a total federal replacement alternative did not meet two aspects of the federal purpose and need for the Proposed Action: (1) it was not competitively priced with NGS; and (2) there was no realistic expectation that surplus revenues could be provided for the Development Fund. Sufficient supplies of natural gas-generated power purchased on the spot market or through a power purchase agreement could potentially provide all of the power and energy necessary to operate CAP at a cost comparable to NGS; however, the availability of surplus – an important component of the purpose and need – under a total federal replacement alternative (i.e., no federal participation in NGS) is remote given current and reasonably foreseeable energy market conditions. Consequently, no total federal replacement alternative was carried forward for evaluation in the EIS.

2.2.3.4 Partial Federal Replacement

The economic analysis described in the previous section led Reclamation to determine that PFR alternatives could satisfy the purpose and need given certain key assumptions, and should be evaluated in the EIS. The final step in the alternatives development process was to formulate PFR alternatives for inclusion in the EIS. Similar to total federal replacement, the availability of surplus under a PFR alternative alone is remote given current and reasonably foreseeable market conditions; however, a PFR alternative paired with continued (but curtailed) federal participation in NGS could meet the federal purpose and need because surplus would continue to be provided by NGS. Therefore, the key assumption for any PFR alternative is NGS (including federal participation) continues beyond 2019. Several other assumptions were established to help formulate PFR alternatives for consideration in the EIS, including:

- NGS operates above minimum load normally during periods when the PFR alternative is not available, supplying power to the CAP and marketing the surplus;
- PFR alternatives replace a portion of the power used for CAP pumping from new or existing sources that are lower emitting than NGS;

[4] $30 to $50 per MW-hour.

- Curtailment[5] of the federal share at NGS would be paired with a power purchase agreement for a corresponding amount of power from the PFR alternative; and
- Any renewable source that is part of a PFR alternative must include its own firming[6] power to ensure reliability.

In addition, the public scoping process revealed three central considerations with respect to alternatives development: 1) seek to minimize energy costs to the CAP; 2) explore renewable energy technology as an economically proven option; and 3) consider tribal socioeconomic impacts.

To address these considerations, and utilizing information from the screening process and economic study, Reclamation defined three conceptual PFR alternatives for incorporation and comparative analysis in the EIS as follows:

(A) A power purchase agreement for power from existing non-coal generating sources (assumed to be natural gas) provided on a 24 hours per day, 7 days per week basis;

(B) A power purchase agreement for power from one or more existing renewable sources for a defined period, 14 hours per day, 7 days per week; and

(C) A power purchase agreement for power from a renewable energy facility (assumed to be photovoltaic solar) built on lands of a tribe affected by actions under this EIS for a defined period, 12 hours per day, 7 days per week.

From the screening process, Reclamation determined that it was not practicable to evaluate site-specific federal replacement options as alternatives in the EIS; therefore, these PFR alternatives are conceptual in nature using a power purchase agreement or request for proposal approach, focusing on technology rather than specific projects.[7] The power purchase agreement or request for proposal approach allows for the consideration and comparison of three lower-emitting generating sources with the Proposed Action and the No Action alternatives (Section 2.3.2).

For purposes of EIS analysis, the range of federal share curtailments at NGS under each PFR alternative was set between 100 MW and 250 MW. Currently, the curtailment range allowed by the NGS Operating Agreement for the federal share is a minimum of 25 MW and a maximum of 309 MW under certain operational and contractual conditions.[8] Reclamation selected 100 MW as the lower bound because it is approximately 30 percent of the maximum allowable federal share curtailment, and is scaled to allow informative environmental impact comparisons with the Proposed Action. Reclamation selected 250 MW as the upper bound because it represents the theoretical maximum federal share

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[5] Curtailment refers to voluntary or involuntary reductions in power output from what could otherwise be produced given available resources. In this case the output from NGS would be cut back or curtailed by an amount specified in a power purchase agreement to offset the amount of power being provided to the CAP by a PFR alternative.

[6] Firming refers to a secondary source of energy to compensate for the normal variability and irregularity of renewable energy generation (e.g., if part of a solar array is shaded by cloud cover) in order to assure delivery of a specific quantity of energy during a defined period of time. NGS cannot be used as a firming source due to its operational constraints as baseload facility.

[7] PFR alternatives developed for EIS purposes are not intended to foreclose any future potential PFR. For example, all 22 options from the inventory analyzed in the screening process that satisfied Criterion 3B (i.e., consistent with partial federal replacement) could be applicable to one or more PFR alternative as shown in **Appendix 2A, Attachment 2A, Table 4**

[8] Under existing arrangements with the NGS Co-tenants (SRP, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company), Reclamation is able to curtail 100 MW. Curtailments exceeding 100 MW would require additional technical, engineering, and cost studies to determine the impact on plant operations, efficiencies, and maintenance. It is anticipated that due to cost and generation implications, additional agreements among the NGS Co-tenants and Reclamation would be necessary prior to curtailments above 100 MW.

curtailment allowable based on potential future NGS operations with the installation of selective catalytic reduction (Salt River Project Agricultural Improvement and Power District [SRP] 2015).

Section 2.3.2 describes the PFR alternatives that are evaluated in detail in the EIS. Additional information on the screening process that was undertaken and reasons for not carrying other action alternatives forward for evaluation in the EIS is provided in **Appendix 2A**.

2.3 Alternatives Evaluated in Detail

This section provides a detailed description of what is reasonably expected to occur under each of the alternatives evaluated in detail in the EIS. The descriptions identify assumptions used in the evaluation of the anticipated environmental impacts described in Chapter 3.0.

2.3.1 Proposed Action

Under this alternative, NGS would be authorized to continue operating two or three units (under certain conditions) from December 23, 2019, through December 22, 2044. The authorization would require the Lease Amendment No. 1 (or a leasing agreement with the Navajo Nation having similar terms as the original NGS Lease and Lease Amendment No. 1) to be approved by the Secretary of the Interior and executed by the Navajo Nation, the NGS Co-tenants, and SRP on behalf of the U.S. NGS would continue to operate to provide electric power to customers, from 2020 through 2044, plus decommissioning. Historical (through 2019) NGS-related operation, maintenance, and repair/replacement practices would be expected to continue during this additional 25-year operational period, except as noted in Section 2.3.1.1.

The Secretary of the Interior also would approve the proposed KMC revised Life-of-Mine (LOM) plan and permit revision application, to identify the timing and sequencing of mining operations in certain coal resource areas to allow historical mining operations to continue uninterrupted at the proposed KMC, which would supply coal to the NGS throughout the 25-year operational period.

Decommissioning and reclamation activities that would occur for both NGS and mining operations after December 22, 2044, are described in this section. Descriptions of ongoing (historical) operations for NGS and the proposed KMC are provided in Section 1.7 of Chapter 1.0, to provide background for understanding the activities that would remain unchanged under the Proposed Action, and the activities that would cease, change, or be added during the period 2020 through 2044, plus decommissioning.

The Secretary of the Interior or designee also would be required to approve a number of other federal actions identified and described in this EIS, prior to implementing the Proposed Action. These actions are included in **Table 1-1** and described in **Appendix 1A**.

2.3.1.1 Navajo Generating Station

Certain adjustments would be made as appropriate to comply with changing environmental regulations, as well as new applicable regulations that become effective during the 2020-2044 time frame. The most significant of these regulations is the Federal Implementation Plan related to the Clean Air Act Regional Haze Rule, which was promulgated August 8, 2014, by the U.S. Environmental Protection Agency (USEPA). This Federal Implementation Plan, regarding site-specific BART provisions at NGS, requires that NGS achieve nitrogen oxide (NO_X) reductions within certain timeframes, while providing the NGS operator a choice among several operating scenarios to meet these reductions. Each of the operating scenarios identified in the Federal Implementation Plan would meet the requirements of a “better than BART” designation, under which NGS is required to operate to meet a 2009-2044 NO_X cap calculated based upon an annual emission rate of 0.055 pounds per million British thermal units (**Appendix 1B**).

The operating scenario ultimately implemented beginning January 2020 would be based, in large part, on the manner in which NV Energy divests of their ownership in NGS prior to December 23, 2019. As mentioned in Section 1.9.3, a decision by NV Energy on how and when it would exit from its ownership and participation in NGS generation, and if it sells its shares to a third-party, could affect the manner in which compliance with the Federal Implementation Plan is undertaken and its timing. As noted above, there are a number of scenarios that could occur; the main difference among them is whether or not NGS would need to generate power and energy in excess of the equivalent of two units operating at optimum capacities, to meet its Participant generation entitlements.

A number of combinations of ownership outcomes and emission reduction strategies could occur, which would determine the operation scenario ultimately implemented under the Proposed Action. For purposes of this EIS, emissions from the Proposed Action were estimated for a range of reasonably foreseeable operation scenarios that could be implemented.

On July 1, 2016, SRP and Los Angeles Department of Water and Power entered into an asset purchase agreement; however, it is unclear when and how NV Energy's divestiture would occur and the future operating scenario that would be implemented. It also is unclear if and when the Navajo Nation would exercise its option under Lease Amendment No. 1 (or a leasing agreement with the Navajo Nation having similar terms as the original NGS Lease and Lease Amendment No. 1) to become a Co-tenant of NGS with an entitlement of up to 170 MW. A number of combinations of ownership outcomes and emission reduction strategies could occur. The ownership outcomes with the highest and lowest resulting emissions were determined to be a 3-Unit Operation with a 2,250-MW capacity and a 2-Unit Operation with a 1,500-MW capacity, respectively. This range of emissions is used in Chapter 3.0 to evaluate the potential impacts that would result from operation of NGS under the Proposed Action. The emissions from the operation ultimately implemented under the Proposed Action, which would fall somewhere within that range, would depend upon the parameters under which the NV Energy divestiture occurs, and whether the Navajo Nation elects to participate in NGS.

Table 2-4 provides a comparison of 3-Unit Operation and 2-Unit Operation at NGS which establishes a foundation for analysis of the range of potential effects for the Proposed Action. Under both the 3-Unit Operation and 2-Unit Operation, 2.7 terrawatt-hours per year of energy would continue to be delivered to CAP.

Table 2-4 Characteristics of the 3-Unit Operation and 2-Unit Operation for the Proposed Action

Key Component	3-Unit Operation	2-Unit Operation
Coal delivery (tons per year [tpy])	8.1 million	5.5 million
Coal handling	Operate 3 units, conveyors, silos	Operate 2 units, conveyors, silos.
Coal storage	12 underground hoppers to receive coal; 30-day coal supply in storage.	Same as the 3-Unit Operation
Design power production (MW)	2,250	1,500
Heat output (million British thermal units per year) (based on actual operations)	194,373,190	129,581,127
Atmospheric Emissions (tons)		
Annual NO_X Emissions (tpy)		
Pre-selective catalytic reduction 0.21 pounds per million British thermal units	20,409	13,606
Post-selective catalytic reduction 0.07 pounds per million British thermal units	6,803	4,535

Table 2-4 Characteristics of the 3-Unit Operation and 2-Unit Operation for the Proposed Action

Key Component	3-Unit Operation	2-Unit Operation
Sulfuric Acid Mist Emissions (tpy)		
Pre-selective catalytic reduction	47.6	31.7
Post-selective catalytic reduction	389	259
Ammonia slip post-SCR	43.7	29.2
Greenhouse Gas (carbon dioxide [CO_2])emissions (tpy)	19,923,252	13,282,168
On-site vehicles	78 light duty vehicles	78 light duty vehicles
On-site heavy equipment	88 mobile source units	88 mobile units
Water allocation (acre-feet per year)[1]	40,000	40,000
Water treatment	NGS is a zero discharge facility, initial evaporation of process water occurs in cooling towers; wastewater is then discharged to evaporation ponds. All plant sewage is treated on-site, and discharged to evaporation ponds. Additional ponds may be constructed within the plant site to accommodate the 2020-2044 operating period; existing ponds may be closed and covered with soil.	Same as the 3-Unit Operation
Chemical/materials use (except ammonia)	See **Table 1-3** for a list of chemicals and volumes.	1/3 less volume than 3-Unit Operation.
Anhydrous ammonia use (tpy) (post-selective catalytic reduction emissions at 0.07 pounds/million British thermal units	17,500	10,500
Anhydrous ammonia deliveries (post-selective catalytic reduction emissions at 0.07 pounds/million British thermal units)	875 truck deliveries per year	535 truck deliveries per year
Mercury (Hg) sorbent use (gallons per year)	1,280,000	853,000
Coal combustion residuals (tpy)	1,440,000	978,000
Solid waste landfill	Inactive 2015	Same as the 3-Unit Operation
Asbestos landfill	Increased landfill capacity is not required to meet 20-year storage requirements; excess material may be transported to an approved facility off-site.	Increased landfill capacity is not required to meet 20-year storage and demolition requirements; excess material may be transported to an approved facility off-site.

Table 2-4 Characteristics of the 3-Unit Operation and 2-Unit Operation for the Proposed Action

Key Component	3-Unit Operation	2-Unit Operation
Coal combustion residual disposal site (765 acres, design capacity of 38 million cubic yards)	Existing disposal site capacity is sufficient; however, lateral extent would be expanded for operations through 2044.	Existing disposal site lateral extent and capacity sufficient for reduced operations through 2044.
Coal combustion residual sales	350,000 to 500,000 tpy; 775-800 trucks per month.	Sales and truck trips 1/3 less than the 3-Unit Operation.
Plant and railroad labor (routine operations) full time equivalents	550	431
Scheduled minor (4 weeks) and major (8 weeks) overhauls	3 years of minor annual overhauls followed by 3 years of major overhauls, to complete a 6-year cycle. Approximately 750 to 800 temporary workers on-site for each overhaul.	2 years of minor annual overhauls followed by 1 year with no overhaul and then 2 years of major annual overhauls followed by 1 year with no overhaul, to complete a 6-year cycle. Approximately 750 to 800 temporary workers on-site for each overhaul.
Community	Community efforts would include funding to benefit NGS Community Chapters, scholarship funds, and local benefit funds.	Community efforts would include funding to benefit NGS Community Chapters, scholarship funds, and local benefit funds.

[1] The projected range of annual NGS water use for the Proposed Action and alternatives is approximately 16,000 to 28,000 acre-feet as described in Section 3.7.4.

Note: The highest and lowest emissions scenarios are described in this table; due to future ownership decisions, the emission rate and other characteristics are expected to fall within the range of these high and low benchmarks.

Under either operation of the Proposed Action, the BM&LP Railroad would continue operations; however, the volume of coal delivered could decrease by about one-third for the 2-Unit Operation. Thus, instead of three trainloads of 8,000 tons of coal each day, the railroad may operate with a different schedule or capacity to meet NGS fuel demand. Fewer train trips or smaller trains hauling less coal would not substantially change maintenance requirements. Anticipated operation and maintenance operations of the BM&LP Railroad and other NGS associated facilities are described in detail in the NGS Operations and Maintenance Plan included in **Appendix 1B**.

2.3.1.1.1 Unit Shutdown Under the 2-Unit Operation

If one NGS unit was shut down after December 22, 2019, immediate actions for the shutdown unit would include draining water and other fluids used in normal operation. Any specific equipment that supports the shutdown unit would cease operation, including de-energizing the operating unit, and removing connections to plant-wide support systems such as coal feeding, unit pulverizers, and support operations for pollution control devices. Following shutdown of the unit, a determination would be made regarding key components, including:

- Maintain in shutdown mode pending completion of an agreement with a new NGS owner, such as the Navajo Nation;
- Sell components as used equipment;
- Maintain key equipment as spare parts;

- Salvage for scrap value;
- Abandon in place until spatial requirements are resolved for selective catalytic reduction installation;
- Abandon in place until final decommissioning;
- Repurpose for use in support of the remaining operating units; or
- Remove material and place in appropriate approved landfill.

Any mix of options, or variant among the above options could apply to any one of the pieces of equipment or support operations at the shutdown unit.

2.3.1.1.2 Decommissioning and Abandonment

Under the Proposed Action, the operating and support facilities at the plant site would be dismantled and demolished to ground level by the end of 2045, unless the Navajo Nation continues NGS operations beyond 2044. Decommissioning[9] of NGS and associated facilities may occur before 2044 consistent with the early termination provisions in the Lease Amendment and other NGS Project agreements. The overall decommissioning process is described in **Appendix 1B**.

The water supply facilities, and certain buildings and equipment would remain, in accordance with the 1969 Lease and Lease Amendment No. 1 (or a leasing agreement with the Navajo Nation having similar terms as the original NGS Lease and Lease Amendment No. 1). Specific facilities that would remain include the following:

- Lake Powell Pump station and both the suction lines between the lake and the pumps and the discharge lines from the pumps to the plant site;
- Administration Building;
- Warehouse;
- Machine Shop Building (currently part of the Service building);
- Visitor's Building (currently part of the Administration building);
- Automotive Maintenance Building (currently the Heavy Equipment building);
- Electric Shop;
- Welding Shop;
- Coal Crusher Building (Currently the Sample and Drive building);
- Roads; and
- Fences.

A comprehensive environmental site assessment would be conducted to determine if there are any sources or paths of contamination and to identify environmental receptors and develop remedial alternatives if applicable. Phase I of the site assessment consists of a records review, site visit, regulatory review, and hydrogeological review to determine if environmental contamination, which may result in future environmental liability is likely to be present at the property. Phase II of the site assessment consists of on-site sampling to determine if environmental issues exist. A sampling and

[9] Decommissioning also is described as "retirement" in the NGS Operating Agreement.

analysis plan would be developed to identify sample locations, sampling methodologies, analytical parameters, and a quality assurance plan.

The equipment required and the general sequence for decommissioning includes:

- Following any asbestos abatement, equipment removal and demolition would be performed by heavy equipment including cranes, loaders, and excavators.
- Backfill, earthmoving, and compaction would be performed using scrapers, front-end loaders, trucks, dozers, and compaction equipment.
- Power, potable water, sanitary facilities, and communication services for dismantling.
- Survey equipment systems and ascertain that no fuels remain.
- Ensure coal has been removed from storage areas, conveyors, hoppers, and feed equipment.
- Ensure fuel oils have been drained and purged from tanks, piping, and pump equipment.
- Ensure sludges and residues have been removed and equipment has been cleaned.
- Recover glass, paper, cardboard, plastics, and metals for recycling.
- Demolish and remove:
  - Boiler room equipment and piping
  - Turbine room equipment and piping
  - Roofing and siding
  - Precipitator area
  - Flue gas desulphurization area
  - Chimneys
  - Boiler room structure (trusses, columns, beams, floors, grating, platform stairways)
  - Turbine room structure (trusses, columns, beams, floors, grating, platforms, stairways)
- Perform sequence similar to that described under demolition for other areas.
- Site closure includes:
  - Remediate any contaminated soils found during demolition
  - Plant native vegetation

Except for hazardous materials and parts and material salvaged, recycled, or sold for scrap, it is anticipated that demolished structural material would be placed within a landfill area on the NGS site, and covered with soil. In accordance with 1969 Lease and Lease Amendment No. 1 (or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1) the coal ash landfill would be left in place and capped with soil material, and revegetated. Hazardous materials would be transported and disposed in compliance with the Resource Conservation and Recovery Act and other applicable requirements. Decommissioning of the BM&LP Railroad would involve removal of overhead power lines, rails, and ties.

As required in the 1969 Lease and Lease Amendment No. 1 (or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1) the land would be restored as closely as possible to original condition where the surface of any leased land has been modified or improved. The areas that do not contain permanent facilities would have all nonindigenous material removed from the surface and the area would be filled and graded to provide proper drainage; however, in accordance with the lease, there would be no attempt to return the leased lands or the ROW to the preconstruction elevations. All restored land would be covered with topsoil indigenous to the area, and revegetated with native plants in order to meet the lease requirements (**Appendix 1B**).

2.3.1.2 Proposed Kayenta Mine Complex

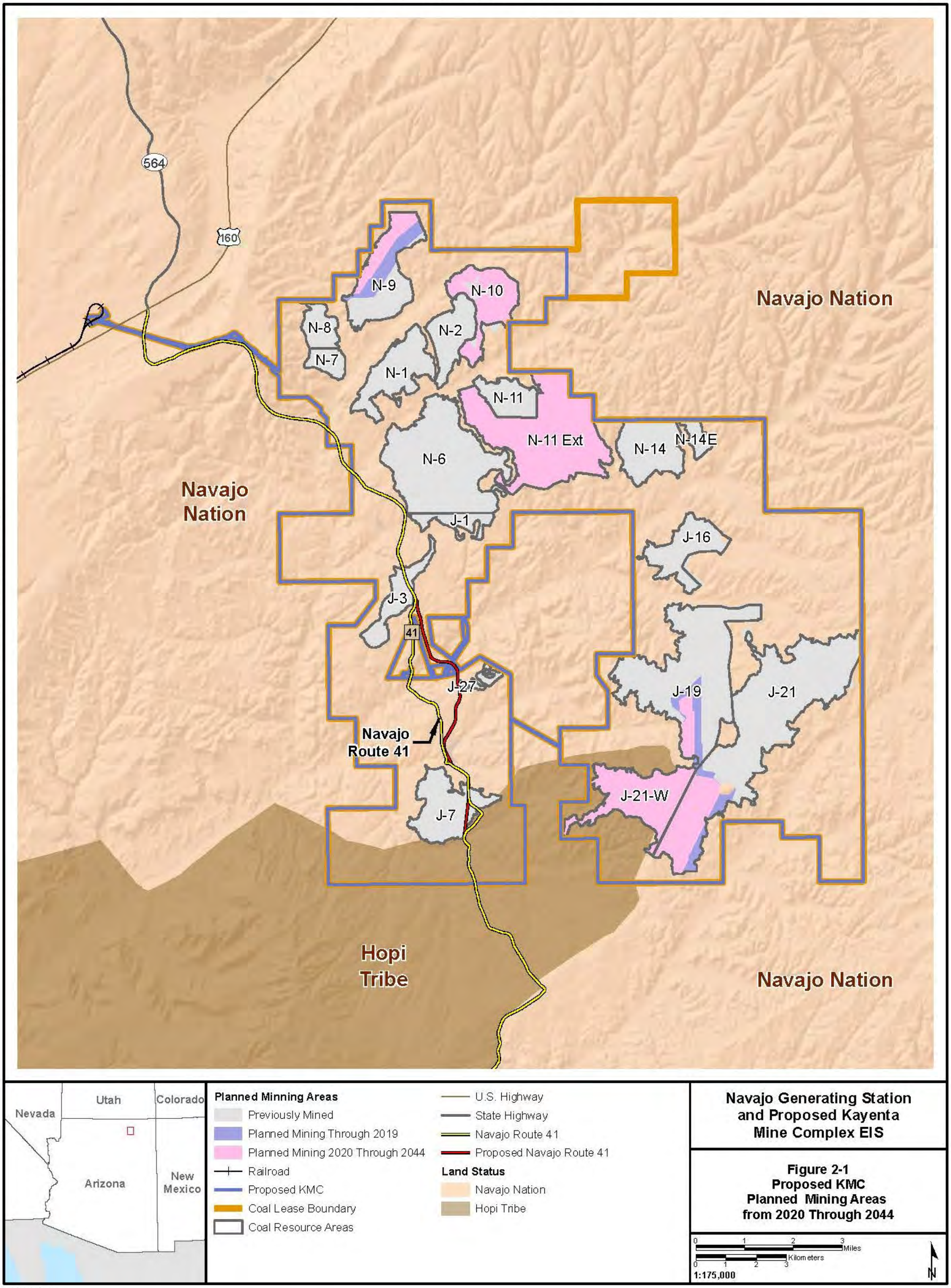
Under the Proposed Action, the Kayenta Mine and former Black Mesa Mine areas would be combined into one permit area consisting of 62,930 acres; the proposed combined area would be called the KMC. The proposed KMC would have a LOM plan equivalent to the life of the NGS and would continue to supply coal to the NGS through the year 2044. OSMRE approvals to mine would continue to be subject to 5-year permit renewals. The volume of coal that would be mined in the 2020-2044 timeframe would depend on the decision to implement a NGS 3-Unit Operation or 2-Unit Operation (requiring delivery of approximately 8.1 million tons per year (tpy) of coal or 5.5 million tpy of coal, respectively). Pit locations proposed for mining would be the same for both coal production scenarios; however, under the 5.5 million tpy scenario, the rate of mining would proceed more slowly than the 8.1 million tpy scenario, and therefore no mining would occur in Mining Area N-10 (**Table 2-5**). As a consequence, the total amount of surface disturbance across all mining units would be less for the 5.5 million tpy scenario than the 8.1 million tpy scenario. The previously approved LOM plan (which could provide coal through at least 2026 without revisions) is designed for 8.1 million tpy production. The LOM plan may be modified periodically to make timing adjustments within each coal resource area. The baseline for evaluating surface disturbance estimates for the period from 2020 through 2044 is the planned disturbance as of December 23, 2019 (PWCC 2012 et seq.).

Table 2-5 Schedule for Coal Mining by Coal Resource Area

Coal Resource Area	NGS 3-Unit Operation (mined coal 8.1 million tpy)	NGS 2-Unit Operation (mined coal 5.5 million tpy)
J-19	2020-2027	2020-2033
N-9	2020-2028	2020-2025
J-21/J-21W	2020-2039	2020-2041
N-10	2029-2043	--
N-11E	2039-2044	2025-2044

No new mining would occur at the former Black Mesa Mine area. The support facilities located in the former Black Mesa Mine area that are being used through 2019 to support mining at the Kayenta Mine would continue to be used through 2044, and would be administered through the Permanent Program Permit AZ-0001E. Lands within the former Black Mesa Mine that remain undisturbed would continue to be administered under the Pre-Law or Initial Program requirements, based upon when they were most recently disturbed. Any new land disturbance proposed in the former Black Mesa Mine area would be subject to compliance with NEPA.

Under the Proposed Action, all mining through the LOM would occur within the existing Kayenta Mine area. Mining would continue in the three existing coal resource areas (N-9, J-19, and J-21) and would be initiated at two new coal resource areas for the 8.1 million tpy scenario (N-10 and N-11 Extension) and at one new coal resource area for the 5.5 million tpy scenario (N-11 Extension). Mining in the J-21 coal resource area would progress onto Hopi-owned surface after 2020; Hopi-owned surface is designated as coal resource area J-21W. **Figure 2-1** depicts the coal resource areas where mining operations would occur from 2020 to 2044. **Table 2-6** provides a schedule for mining from 2020 through 2044 at each of the individual coal resource areas. Mining at coal resource area N-9 would occur during the earlier years of this time period, and shift to coal resource area N-11E. For mining associated with both the 3-Unit Operation and 2-Unit NGS Operation, mining would occur in coal resource area J-21/J-21W for most of the period, until 2039 or 2041.



Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 2-1
Proposed KMC
Planned Mining Areas
from 2020 Through 2044

7/20/2016

Table 2-6 Proposed Production by Coal Resource Area 2020 through 2044 (based on 3-Unit Operation)

Coal Resource Area	Production 2020-2024 (tonsX1000)	Production Beyond 2024 (tonsX1000)
J-19	11,617.0	9,680.9
J-21	10,805.9	43,076.2
J-21 West	7,093.4	46,781.9
N-9	10,750.9	104.7
N-10	0	24,861.4
N-11E	0	68,532.0

Under the Proposed Action, vegetation clearing, topsoil removal and mining methods would continue. The existing coal preparation facilities at the coal resource area J-28, and mine areas N-11 and N-8 would be used; no new coal preparation facilities would be constructed. Coal removed from the northern coal resource areas (N-9, N-10, and N-11E) would be hauled by truck to the N-11 coal preparation area, where it would be crushed, screened, and transferred by conveyors to the N-8 coal preparation area. Coal removed from the southern coal resource areas (J-19 and J-21/J-21W) would be hauled by truck to the J-28 coal preparation area where it would be processed and conveyed to the N-8 coal preparation area. At the N-8 coal preparation area, the coal would be stockpiled, blended, or conveyed directly to the silo and rail load-out.

Table 2-7 provides a summary of proposed KMC activities that would occur from 2020 through 2044 under the Proposed Action. As indicated previously, the infrastructure components required to support the higher and lower coal production rates would be the same. The primary source of mine plan information for the proposed KMC is the LOM Plan Significant Revision that was submitted to OSMRE by PWCC in March 2015 (PWCC 2012 et seq.).

Table 2-7 Proposed KMC Activities – 2020-2044

	Proposed Action (5.5 and 8.1 Million tpy Coal Production)
Permit and Affected Areas	The Kayenta Mine and former Black Mesa Mine areas would be combined into the proposed KMC. Activities at both areas would be administered through the Permanent Program Permit AZ-0001E. Affected lands would fall into either Pre-Law, Initial Program or Permanent Program requirements based on when the lands were most recently affected.
Mining Requirements	8.1 million tpy: Continued mining in coal resource areas N-9, J-19, and J-21. Mining in new coal resource areas N-10, N-11 Extension, and J-21W. 5.5 million tpy: Same mining areas as the 8.1 million tpy scenario except no mining would occur in coal resource area N-10. LOM extended through 2044. No change to mining methods. Additional topsoil stockpiles would be created as topsoil salvage occurs in new mine areas.
Support Facilities	Use of the support facilities located on the former Black Mesa Mine would continue through the LOM.
Coal Handling and Storage	No changes proposed in coal preparation facilities. Coal mined at coal resource areas N-10 and N-11 Extension would be handled at the existing N-11 coal preparation area.

Table 2-7 Proposed KMC Activities – 2020-2044

	Proposed Action (5.5 and 8.1 Million tpy Coal Production)
Water Use and Management	New temporary sedimentation ponds would be constructed through the LOM. Predicted groundwater use (both mining scenarios): 2020-2044 1,200 acre-feet per year. 2045-2047 500 acre-feet per year (reclamation). 2048-2057 100 acre-feet per year (vegetation establishment and bond release).
Roads	No new primary or ancillary roads are proposed for mining in new coal resource areas. Primary and ancillary routes already have been established. Pit ramps would continue to change within existing and new mine areas as mining progresses.
Navajo Route 41	PWCC proposes to reconstruct Navajo Route 41 in its approximate original location and reclaim the reroute as approved.
Fuel storage, Vehicle Maintenance areas, and Explosives Storage	No changes proposed to existing fuel storage, vehicle maintenance areas, and explosives storage.
Solid and Hazardous Waste Disposal	No changes proposed to solid and hazardous waste disposal.
Airfield	No changes proposed to existing airfield facilities.
Air Quality Control and Monitoring	Continued operation of existing monitoring activities and locations.
Water Quality and Quantity Monitoring	Continued operation of existing monitoring activities and locations.
Jurisdictional Bonding Requirements	With combination of the Kayenta Mine and former Black Mesa Mine as the proposed KMC, the reclamation bond would be revised to include the former Black Mesa Mine facilities being used in support of operations at the Kayenta Mine. The bond would be periodically reviewed and adjusted as necessary. The initial and Pre-Law areas at the Kayenta Mine and the former Black Mesa Mine are bonded for reclamation through lease bonds.
Mine Reclamation Requirements	Disturbed areas would be reclaimed to approximate landforms that existed prior to mining and revegetated using vegetation similar to surrounding areas to support the post-mining land use of rangeland grazing, wildlife habitat, and cultural plantings.
Abandonment/ Decommissioning	Facilities would be abandoned and removed after 2044 unless approved by OSMRE and the Navajo Nation as a permanent facility.
Community	Community efforts through 2019 would continue through 2044, including the provision of potable water; emergency medical services; snow removal; water hauling for livestock; firewood from slash piles; coal (free or at a cost) to members of the community; managed grazing on reclaimed lands; and, the provision of certain compensation for residents within or near mining and related activities.

Additional topsoil stockpiles and additional drainage and sediment control structures would be added as mining progresses. No other new support facilities are anticipated for the LOM.

The mine's work force would remain at or near historical levels through the LOM under the NGS 3-Unit Operation, which is approximately 440 full-time employees. For the NGS 2-Unit Operation, employment is estimated at 299 full-time employees. Existing programs supporting community water supply initiatives and providing access to coal and timber would continue.

In the years 2040 through 2044, additional equipment would be added to account for the increase in the stripping ratio or amount of overburden required to be removed in relation to the amount of coal to be mined. This ratio would increase in 2040 from approximately 5:1 to 7:1. The resulting need for additional equipment would be handled through contractor equipment and associated operators.

Mine reclamation activities including grading, spoil sampling, subsoil and topsoil replacement and seeding would be conducted in the same manner as the historical operations. Reclamation plans would be updated periodically to adjust for changes in timing or unique land conditions and reviewed and approved by OSMRE for compliance with federal regulations. Proposed KMC reclaimed areas would be monitored for reclamation success with reseeding and repair of any erosional features which have formed on reclaimed areas, as needed. No support facility reclamation would be completed until the cessation of mining in 2044.

Ambient air quality and meteorological monitoring would continue at sites within the proposed KMC under the Proposed Action. Continued operation of hydrologic monitoring sites including wells, springs, and streams for sampling water quality and quantity at the Kayenta Mine and at the former Black Mesa Mine also would continue under the Proposed Action, and reporting requirements to OSMRE would remain the same as under historical operations.

2.3.1.2.1 Navajo Route 41 Realignment

As part of the Proposed Action, Navajo Route 41 would be realigned (see **Figure 2-1**). Navajo Route 41 is an open range, paved/graveled road which does not have a recorded ROW and receives limited maintenance. PWCC provides maintenance of Navajo Route 41 from its intersection with U.S. Highway 160 to the southern permit boundary of the mine site to ensure safe employee access to the mine site; however, no agreement for maintenance exists. Other portions of the route are not routinely maintained.

Two portions of Navajo Route 41 are proposed for realignment by PWCC that were initially rerouted after consultation with OSMRE, the Navajo Transportation Department, and Bureau of Indian Affairs. The first portion to be realigned is located from south of the former Black Mesa Mine Reclamation Complex to south of the former Black Mesa Mine facilities area. The original Navajo Route 41 alignment was within PWCC's mine area and was used by PWCC as a primary mine road for mine traffic; public traffic also was allowed. OSMRE requested that PWCC separate the public traffic from the mine traffic and PWCC created the existing alignment for Navajo Route 41. As part of the LOM plans, PWCC proposes to realign Navajo Route 41, placing the route back in its approximate original configuration along PWCC's now-abandoned primary mine road. The realignment would straighten the road and make the route a more consistent elevation, eliminating a steep drop and curve (PWCC 2012 et seq.).

A second portion of Navajo Route 41 was temporarily rerouted to allow maximum coal recovery in the J-7 mine area of the former Black Mesa Mine as shown on **Figure 2-1**. Mining in the J-7 mine area was completed in 2005 and reclamation of the mine area was completed in 2010. PWCC plans to realign Route 41 in approximately the same location as the original alignment using the J-7 Ramp #1 and haul road system. A portion of the realignment also crosses Hopi tribal land.

Realignment of both sections is expected to be completed no later than 2025. PWCC would submit a new permit revision for appropriate regulatory approval with the proposed alignment and a request to permit these roads as permanent roads. The proposed construction of these realignment portions is included in the Proposed Action.

2.3.1.2.2 Decommissioning and Abandonment, Disposition of Mine Facilities and Final Reclamation

Facility removal, backfilling, grading, topsoil replacement and revegetation is expected to take 2 to 3 years after cessation of mining at the end of 2044. Final reclamation release, lease relinquishment and termination of jurisdiction is expected to take approximately 10 to 15 years after mining ends to allow for the revegetation to become established and ensure long-term stability of reclaimed areas (a minimum of 10 years after reclamation pursuant to Surface Mining Control and Reclamation Act). A reclamation bond would be maintained for the lands affected under the Permanent Program until final reclamation release. Water would continue to be pumped from groundwater wells for dust control and to assist with reclamation activities at the rate of approximately 500 acre-feet per year from 2045 through 2047; groundwater withdrawals would continue at the rate of approximately 100 acre-feet per year from 2048 through 2057. Mine closure and reclamation activities, which are detailed in the permit application package, would include the following:

- Completion of approved mine plan through 2044 and cessation of mining after 2044.
- Decommissioning and removal of surface structures, facilities, and mining equipment after 2044.
- Completion of the approved reclamation process for mine areas, facilities areas, and any other disturbance not approved as permanent facilities.
- Monitoring of reclaimed areas until the final bond release.
- Release of reclamation bond.

Mine facilities with economic value would be decommissioned and the materials removed for salvage. Non-salvageable facilities would be buried. Concrete foundations and sub-bases would be removed or buried in place if approved by OSMRE. If the foundations are buried in place, the cover over these structures would be a minimum of four feet. Grading, topsoil replacement and seeding would occur for the facilities areas as described in the approved permit application package.

2.3.1.3 Transmission Systems and Communication Sites

Under the Proposed Action, no construction, major replacement, or other activities beyond continued operation and as-needed maintenance are anticipated for the transmission line systems, substations, and communications sites. Ongoing maintenance, repair, replacement, and improvement of the transmission lines would continue. These activities include aerial and ground inspection, repair and replacement of transmission system components, and ROW vegetation treatment to reduce safety hazards. The majority of all inspection and maintenance activities would occur along the existing ROW, serviced by existing roads leading to the regional highway system. In the event that new roadways are required to access the transmission line ROW, the transmission line operators would apply for and obtain temporary access permits to conduct repair and maintenance activities from the applicable land management agency. Operation and maintenance activities are further described in **Appendix 1B**.

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

2.3.1.4 Community Assistance and Environmental Measures

Based on the results of public scoping, and the issues and concerns described in this EIS, Reclamation and the project proponents (SRP and PWCC) have developed measures and associated commitments to provide assistance to the communities directly affected by the Proposed Action and alternatives, and to provide environmental monitoring and other protection measures in response to identified environmental impacts. All the project components are currently operating, and are subject to existing federal regulation, and future authorizing actions (**Table 1-1**). A discussion of best management practices (BMPs) mitigation and voluntary commitments that are currently in place are discussed in Chapter 4.0, Mitigation and Voluntary Commitments. Best management practices for NGS and the proposed KMC also are included in **Appendix 1B** and **1D**, respectively.

2.3.1.4.1 Community Assistance

In response to concerns received during scoping, and interviews during the course of preparing this EIS, quality of life concerns were raised by community members living within and adjacent to the proposed KMC. The following measures were developed by the project proponents (i.e., NGS Participants and PWCC) to address these concerns.

Proponent-sponsored Stove Replacement Program

Need for the measure:

- Many Navajo community members burn both wood and coal for heating and cooking in the area surrounding the proposed KMC. PWCC provides community residents with coal for winter heating. Stoves used for these purposes are of varying quality and efficiency, and in some cases, stoves are improvised from available materials. This measure would addresses a primary quality of life concern that the use of poor quality or improperly ventilated stoves by Navajo residents for indoor heating and cooking can lead to poor indoor air quality and potential health impacts.

Measure description:

- If USEPA certified coal stoves are available, SRP (on behalf of the NGS Participants), and in coordination with PWCC and Navajo Nation Environmental Protection Agency(NNEPA), would establish a stove replacement and installation program to benefit the residents within and surrounding the mine permit area. SRP would coordinate with NNEPA to provide input to the program.
- The program would be established between 2020 and 2025; up to $1M will be made available by SRP for the exchange program (it is estimated that an EPA certified coal/wood stove would cost approximately $5000 installed). Thus, the $1M in funding would provide for approximately 200 stoves.
- If funds remain at the end of 2025, the funds would be deposited in the NGS Community Fund that was established when Lease Amendment No. 1 is signed by the non-federal NGS Participants; NGS would coordinate with NNEPA to provide funding for key Navajo program(s) that address air quality concerns near the mine lease area.

Proponent-sponsored KMC Community Liaison

Need for the measure:

- During meetings with residents living within the proposed KMC during the preparation of this EIS, concerns were expressed about the frequency and detail of communications on mine activities that affect the daily lives of residents. These concerns focused on periodic changes in mining location and residential relocations, access to grazing areas and surface water, and exposure to mining-generated dust and noise (see Sections 3.16, Public Health, and Section 3.18, Socioeconomics).

Measure description:

- PWCC would continue to provide one full time equivalent employee for a tribal Community Liaison position for the proposed KMC area and the Black Mesa Community. PWCC would direct and oversee, and Reclamation and OSMRE would coordinate with and provide input to PWCC regarding this position. The Community Liaison would interface with residents, tribal departments (Navajo Nation and Hopi Tribe), project proponents, and affected federal agencies on a regular basis, providing a mechanism to more pro-actively address resident concerns during mining, and plan for the transition to post-mining use of the area. A communications framework for regularly scheduled reporting on issues and progress would be developed and carried out by this position.

- The effectiveness of the position would be subject to periodic reviews planned and organized by PWCC no less than once every 5 years. This review would be led by Reclamation and include PWCC, OSMRE, residents, tribal departments (Navajo Nation and Hopi Tribe), Project Proponents, and affected federal agencies. This review would recommend changes to the way in which PWCC addresses resident concerns during mining, effectiveness of communications, the transition to post-mining use of the area, and a determination if the Liaison role should be continued until the next 5-year review.

Reclamation-sponsored Technical Support

Need for the measure:

- During meetings with residents living within the proposed KMC during the preparation of this EIS, concerns were expressed about the lack of potable water service to homes near the mine. The lack of potable water service across the Navajo Nation is well documented. As mentioned in Section 3.18.3.1, the Navajo Tribal Utility Authority estimates that 15,000 families are without access to electricity and many more are without access to running water. There are a number of municipal water projects on the Navajo Nation in various stages of planning to address this issue (e.g., the Many Mules Water Project described in Section 3.18.3.1).

Measure description:

- Through its existing Memorandum of Understanding with the Navajo Nation, first established in 2001 and reaffirmed by the Commissioner of Reclamation and Navajo Nation President in 2016, Reclamation would provide technical assistance to promote water development projects across the Navajo Nation. Technical assistance would be provided in coordination and cooperation with the Navajo Nation government, and is subject to appropriations, authority and program criteria.

2.3.1.4.2 Proponent Committed Environmental Measures

This section provides a summary of measures that were developed in response to identified environmental impacts, or need for environmental monitoring.

2.3.1.4.2.1 Water Resources

WR-1 Black Mesa USGS Water Resources Monitoring

Need for the measure:

The USGS water resources monitoring program that was initiated in the 1970's has provided essential information used to describe environmental impacts in this EIS, and input to groundwater modeling. The data resulting from a continuation of existing monitoring at selected locations would assist in confirming impacts predicted in this EIS, and would provide inputs to the Kayenta Mine regional groundwater model.

Measure description:

PWCC would continue to financially support the existing U.S. Geological Survey (USGS) Black Mesa water resources monitoring program on a proportional share basis along with the other participants in the program. PWCC would continue to interact with the USGS, Navajo Nation, Hopi Tribe, OSMRE, and other participating agencies to determine ongoing water resources monitoring needs sufficient to maintain the program as needed.

WR-2 Update of the D-Aquifer and N-Aquifer Groundwater Flow Model

Need for the measure:

Management of groundwater and surface water resources on Black Mesa will require comparisons of measured and modeled water levels over the next 20 years to make decisions. Updating and modifying the model to better characterize the groundwater system and the effects of pumping would assure that decisions are based on the best available information.

Measure description:

In or about the year 2036, PWCC and a groundwater modeling team would update and perform re-calibration of the existing multi-layer D- and N-Aquifer groundwater flow model. This work would incorporate new, updated inputs for: observed water levels in wells; stream baseflow; conditions at springs and other pertinent discharge locations; and mine-related, community, and other pumping withdrawals. Data and information gained from the regional cooperative monitoring program (see WR Monitoring Measure 1, above) would be used as inputs and for calibration. Techniques and routines for modeling and calibration also would be reviewed and updated as necessary, to ensure that improvements in groundwater modeling technology are appropriately applied. Through coordination with appropriate agencies, groundwater modeling outputs would be tailored to the needs of applicable environmental regulatory requirements at the time.

WR-3 Water Quality Sample Analysis and Reporting Limits

Need for the measure:

Since water quality standards and approved laboratory analytical methods change over time, the mine-related water quality monitoring program will need to maintain coordination with appropriate regulatory agencies to collect applicable data.

Measure Description:

All surface water and groundwater quality analyses at the KMC would continue to be conducted and reported according to approved laboratory analytical methods and reporting limits determined and approved through coordination with OSMRE, the NNEPA, and the Hopi Tribe Water Resources Program.

2.3.1.4.2.2 Biological Resources

During formal consultation under Section 7 of the Endangered Species Act of 1973, Reclamation, the U.S. Fish and Wildlife Service, the key cooperating agencies, and SRP (on behalf of the NGS Participants) initiated development of Conservation Measures that would offset impacts to listed and candidate species. These Conservation Measures are presented in the biological resource sections in this EIS for individual species, as well as in the Biological Assessment, Chapter 3.0 Conservation Measures. These Conservation Measures include new measures designed to protect fish and wildlife species and their designated habitats, as well as BMPs that have been included in prior transmission line consultations conducted for the STS and WTS, or similar transmission lines, or are included in the Navajo Project Operation and Maintenance Plan (**Appendix 1B**). All biological Conservation Measures used in this EIS are presented in the Biological Assessment released concurrently with this Draft EIS.

2.3.2 Partial Federal Replacement Alternatives

As described previously in Section 2.2.3.2, technical and economic analyses indicated the concept of PFR would meet the purpose and need of the Proposed Action. Through the public scoping process, three central themes with respect to alternatives development became evident: 1) seek to minimize energy costs to the CAP; 2) explore renewable energy technology as an economically viable option; and 3) consider tribal socioeconomic impacts.

The concept of partial replacement is analyzed in this EIS through three PFR alternatives consisting of the use of a power purchase agreement to acquire energy from a non-coal source under a specified schedule, displacing an equivalent amount of power from the federal share of NGS generation. To facilitate the comparison of the PFR alternatives impacts to those of the Proposed Action, the PFR alternatives are defined conceptually as obtaining 100 MW up to 250 MW from one of three sources: the lowest cost lower emitting energy source (i.e., natural gas); a renewable energy source; and a source of renewable energy located on tribal land. Using a consistent generating capacity range allows the comparison of differences to be focused on the environmental and socioeconomic impacts from the sources of replacement power, including the particular constraints and flexibilities that each possesses.

Although the three PFR alternatives are consistent in the specification of 100 MW to 250 MW of peak energy to be obtained from a lower-emitting source, they differ in the source of the replacement power and energy, the total amount of energy provided over time, and commensurately, the amount of energy by which NGS would be curtailed. Regardless of the mix of power generation options that could result from implementation of a partial federal share replacement, the quantity of power delivered to the CAP system would remain the same.

The following PFR alternatives considered in the EIS address one of the three central themes identified during public scoping with respect to alternatives development; additional summary level detail on each alternative can be found in subsequent sections, and **Appendix 2A** provides a detailed description of each PFR alternative and the anticipated changes to NGS and associated facilities and the proposed KMC.

For all PFR alternatives, the use, operation, maintenance and repair/replacement of the transmission systems and communication sites would be the same as described for the Proposed Action.

2.3.2.1 Natural Gas PFR Alternative

The selected quantity of firm power between 100 MW and 250 MW would be contracted for under a long-term power purchase agreement from existing natural gas generation sources, with energy supplied to the CAP on a 24-hour per day, 7-day per week basis. NGS would curtail its output by the corresponding amount, continuing operations to meet the remaining federal share and market surplus. This alternative utilizes existing natural gas resources to reduce net emissions and minimize resulting cost increases,[10] while maintaining the availability and value of surplus energy from NGS at about the same quantities as under the Proposed Action. The following sections describe how the project component operations and employment (NGS, proposed KMC, and the transmission system) would be modified by the reductions in NGS energy output. See **Appendix 2A** for detailed description of the Natural Gas PFR Alternative and the anticipated changes to NGS and associated facilities, the proposed KMC, and transmission systems.

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[10] All PFR alternatives would have an incremental cost increase versus power for CAP from NGS alone (National Renewable Energy Laboratory 2015a); natural gas was the least-cost technology.

2.3.2.1.1 Navajo Generating Station

Table 2-8 provides estimates of NGS and the Natural Gas PFR Alternative annual energy output, as well as the changes in energy deliveries to CAP from NGS. Reductions in deliveries to CAP from NGS under this PFR alternative would be offset by energy purchases from a natural gas source, such that the sum of the federal energy from NGS supplied to CAP and the PFR alternative energy supplied to CAP would equal the 2.7 terrawatt-hours per year of energy delivered to CAP by the Proposed Action (either 3-Unit Operation or 2-Unit Operation). The opportunity for sales of surplus energy would remain the same for both the Proposed Action and the Natural Gas PFR Alternative, but the amount of potential NGS surplus energy would be slightly less under the 2-Unit Operation due to the reduction in the federal share of energy for a 2-Unit Operation.

Table 2-8 Annual NGS Proposed Action and Natural Gas PFR Energy Output

Configuration	Proposed Action	Natural Gas PFR 100-MW Reduction	Natural Gas PFR 250-MW Reduction
NGS - 3-Unit Operation, 547-MW Federal Share			
Federal Energy from NGS (TWh/yr) [1]	4.17	3.29	1.98
Federal Energy from NGS Supplied to CAP (TWh/yr)	2.70	1.82	0.51
Energy from PFR source delivered to CAP (TWh/yr)	--	0.88	2.19
NGS Energy Available as Surplus (TWh/yr)	1.47	1.47	1.47
NGS – 2-Unit Operation, 540-MW Federal Share			
Federal Energy From NGS (TWh/yr)	4.12	3.24	1.93
Federal Energy Supplied to CAP from NGS (TWh/yr)	2.70	1.82	0.51
Energy from PFR source delivered to CAP (TWh/yr)	--	0.88	2.19
NGS Energy Available as Surplus (TWh/yr)	1.42	1.42	1.42

[1] TWh/yr = terawatt-hours per year. 1 terawatt equals 1 trillion (1,000,000,000,000) watts.

No modifications to NGS coal handling equipment, generation equipment, water delivery, and waste disposal procedures would be required to implement the Natural Gas PFR Alternative. There would be a reduction in BM&LP Railroad trips, as well as water and chemical use proportional to the reduced quantity of coal burned for energy generation. These reductions would range from 5 to 19 percent less than under the Proposed Action.

It is anticipated that fewer direct, indirect and induced employment would occur in response to lower energy output. **Table 2-9** provides a general estimate of regional employment changes under the Natural Gas PFR Alternative relative to the Proposed Action.

Table 2-9 Regional Employment Associated with NGS under the Natural Gas PFR Alternative

Regional Employment	Regional Employment Numbers			
	3-Unit Operation NGS		2-Unit Operation NGS	
	Natural Gas 100-MW Reduction	Natural Gas 250-MW Reduction	Natural Gas 100-MW Reduction	Natural Gas 250-MW Reduction
New Regional Jobs Tied to Alternative Power	0	0	0	0
Total Regional Jobs (direct, indirect & induced): Typical Year	2,077 87 fewer than Proposed Action	1,999 165 fewer than Proposed Action	1,535 81 fewer than Proposed Action	1,453 163 fewer than Proposed Action

Under the Natural Gas PFR Alternative, decommissioning and final reclamation of the NGS and associated facilities and BM&LP Railroad would be the same as described for the Proposed Action.

2.3.2.1.2 Proposed Kayenta Mine Complex

Table 2-10 provides estimates of reductions in coal mined at the Kayenta Mine under the Natural Gas PFR Alternative in relation to the Proposed Action. No modifications to proposed KMC coal mining and handling equipment, mining procedures and reclamation, groundwater use, and waste disposal procedures would be required to implement the Natural Gas PFR Alternative. There would be a reduction in energy required to mine coal, and less surface disturbance from mining. On a proportional basis, these reductions would range from 5 to 18 percent less than under the Proposed Action.

Table 2-10 Annual Coal Mined for NGS Under the Natural Gas PFR Alternative

Configuration	Proposed Action	Natural Gas PFR 100-MW Reduction	Natural Gas PFR 250-MW Reduction
NGS – 3-Unit Operation			
Annual Coal Mined (in million tons) Percentage Difference from Proposed Action [1]	8.1 NA	7.7 -5%	7.1 -12%
NGS – 2-Unit Operation			
Annual Coal Mined (in million tons) Percentage Difference from Proposed Action[1]	5.5 NA	5.1 -7%	4.5 -18%

[1] Differences in tons of coal are relative to the base tonnages for the corresponding 3-Unit Operation or 2-Unit Operation under the Proposed Action.

Table 2-11 provides estimates of regional employment changes as the result of less coal mined under the Natural Gas PFR Alternative. As indicated in the table, the greatest employment reductions would be associated with the 250-MW NGS energy replacement operation.

Table 2-11 Regional Employment Associated with the Proposed Kayenta Mine Complex Under the Natural Gas PFR Alternative

Regional Employment	Regional Employment Numbers			
	3-Unit Operation NGS		2-Unit Operation NGS	
	Natural Gas 100-MW Reduction	Natural Gas 250-MW Reduction	Natural Gas 100-MW Reduction	Natural Gas 250-MW Reduction
Employment (direct, indirect and induced) – Typical Year	1,573 75 fewer than Proposed Action	1,453 195 fewer than Proposed Action	1,052 77 fewer than Proposed Action	939 190 fewer than Proposed Action

Decommissioning and final reclamation of the proposed KMC would occur as described under the Proposed Action.

For all PFR alternatives, the use, operation, maintenance and repair/replacement of the transmission systems and communication sites would be the same as described for the Proposed Action.

2.3.2.2 Renewable PFR Alternative

Under the Renewable PFR Alternative the selected quantity of firm power between 100 MW and 250 MW would be contracted for under a long-term power purchase agreement from existing renewable generation sources, with energy supplied to the CAP during a defined time period of 14 hours per day, 7 days a week, a duration which generally corresponds to the period of high commercial and residential demand and the availability of renewable generation in the southwest. Generation from two or more sources would be required to supply the necessary level of power for the defined duration. The power purchase agreement for this alternative would require that “firming” be included for the defined period of delivery to maintain reliability during short-term fluctuations in output (e.g., cloud cover); however, “firming” is not intended to augment output from the renewable source to achieve a steady 100 MW to 250 MW over the entire period. [11] The net result would be replacement power providing an average of between 58.3 MWh and 145.8 MWh per hour over the course of a 24-hour period.

Energy deliveries from the renewable sources would be monitored over time and curtailment at NGS scheduled to achieve the necessary reduction in NGS production and associated reductions in coal combustion. The curtailment would not necessarily be concurrent with the scheduled delivery of energy from the renewable sources to the CAP, however reductions in the amount of power produced at NGS would occur over a yet-to-be determined period of time, i.e., monthly, quarterly or yearly, to total that supplied by renewable sources. Non-concurrent curtailment provides flexibility to optimize operations of NGS, while still assuring achievement of the established levels of emission reductions, and maintains the availability and value of surplus energy from NGS at about the same quantities as under the Proposed Action.

The following sections describe how the project component operations and employment (NGS, proposed KMC, and the transmission system) would be modified by the reductions in NGS energy output compared to the Proposed Action. See **Appendix 2A** for detailed description of the Renewable PFR alternative and the anticipated changes to NGS and associated facilities, the proposed KMC, and transmission system.

[11] “firming” refers to a secondary source of power to compensate for the normal variability and irregularity of energy generation from a solar facility, i.e., if part of the array is shaded. Renewable sources cannot serve as a “firming” source because they do not offer the necessary reliability and responsiveness.

2.3.2.2.1 Navajo Generating Station

Table 2-12 provides estimates of the Proposed Action and the Renewable PFR Alternative annual energy output, as well as the relative reduction in energy deliveries from NGS to CAP, which would be offset by energy purchases from a renewable energy source. See the Natural Gas PFR Alternative for how the alternative energy supplied to CAP relates to NGS energy delivery to CAP, and the quantity of NGS energy available for surplus.

Table 2-12 Annual Energy Output for the Proposed Action and Renewable PFR Alternative

Configuration	Proposed Action	Renewable PFR 100-MW Reduction	Renewable PFR 250-MW Reduction
NGS – 3-Unit Operation, 547-MW Federal Share			
Federal Energy From NGS (TWh/yr) [1]	4.17	3.66	2.89
Federal Energy Supplied to CAP (TWh/yr)	2.70	2.19	1.42
Energy from PFR source delivered to CAP (TWh/YR)	--	0.51	1.28
NGS Energy Available as Surplus (TWh/yr)	1.47	1.47	1.47
NGS – 2-Unit Operation, 540-MW Federal Share			
Federal Energy From NGS (TWh/yr)	4.12	3.61	2.84
Federal Energy Supplied to CAP From NGS (TWh/yr)	2.70	2.19	1.42
Energy from PFR source delivered to CAP (TWh/YR)	--	0.51	1.28
NGS Energy Available as Surplus (TWh/yr)	1.42	1.42	1.42

[1] TWh/yr = terawatt-hours per year. 1 terawatt equals 1 trillion (1,000,000,000,000) watts.

No modifications to NGS coal handling equipment, generation equipment, water delivery, and waste disposal procedures would be required to implement the Renewable PFR Alternative. There would be a reduction in BM&LP Railroad trips, and water and chemical use proportional to the reduced quantity of coal burned for energy generation. These reductions would range from 3 to 11 percent less than under the Proposed Action.

It is anticipated that fewer employees would be required at NGS in response to lower energy output. **Table 2-13** provides a general estimate of regional employment changes under the Renewable PFR Alternative relative to the Proposed Action.

Table 2-13 Regional Employment Associated with NGS Under the Renewable PFR Alternative

Regional Employment	Regional Employment Numbers			
	3-Unit Operation NGS		2-Unit Operation NGS	
	Renewable 100-MW Reduction	Renewable 250-MW Reduction	Renewable 100-MW Reduction	Renewable 250-MW Reduction
New Regional Jobs Tied to Alternative Power	0	0	0	0
Total Regional Jobs (direct, indirect & induced): Typical Year	2,096 68 fewer than Proposed Action	2,054 110 fewer than Proposed Action	1,559 57 fewer than Proposed Action	1,509 107 fewer than Proposed Action

Under the Renewable PFR Alternative, decommissioning and final reclamation of the NGS and BM&LP Railroad would be the same as described for the Proposed Action.

2.3.2.2.2 Proposed Kayenta Mine Complex

Table 2-14 provides estimates of reductions in coal mined at the Kayenta Mine under the Renewable PFR Alternative in relation to the Proposed Action. Less reduction in coal mining would occur than the Natural Gas PFR Alternative because the renewable alternative energy source would not deliver as much energy to CAP, requiring more energy to be delivered from NGS. No modifications to the proposed KMC coal mining and handling equipment, mining procedures and reclamation, groundwater use, and waste disposal procedures would be required to implement the PFR alternative. There would be a reduction in energy required to mine coal, and less surface disturbance from mining. On a proportional basis, these reductions would range from 2 to 11 percent less than under the Proposed Action.

Table 2-14 Annual Coal Mined for NGS Under the Renewable PFR Alternative

Configuration	Proposed Action	Renewable PFR 100-MW Reduction	Renewable PFR 250-MW Reduction
NGS – 3-Unit Operation			
Annual Coal Mined (in million tons) Percentage Difference from Proposed Action[1]	8.1 NA	7.9 - 2%	7.5 - 7%
NGS – 2-Unit Operation			
Annual Coal Mined (in million tons) Percentage Difference from Proposed Action[1]	5.5 NA	5.3 - 4%	4.9 - 11%

[1] Differences in tons of coal are relative to the base tonnages for the corresponding 3-Unit Operation or 2-Unit Operation under the Proposed Action.

Table 2-15 provides estimates of regional employment changes as the result of less coal mined under this PFR alternative. As indicated in the table, the greatest employment reductions would be associated with the 250-MW energy replacement operation.

Decommissioning and final reclamation for the proposed KMC would occur as described under the Proposed Action.

Table 2-15 Regional Employment Associated with the Proposed KMC Under the Renewable PFR Alternative

Regional Employment	Regional Employment Numbers			
	3-Unit Operation NGS		2-Unit Operation NGS	
	Renewable 100-MW Reduction	Renewable 250-MW Reduction	Renewable 100-MW Reduction	Renewable 250-MW Reduction
New Regional Jobs Tied to Alternative Power	0	0	0	0
Total Regional Jobs (direct, indirect & induced): Typical Year	1,603 45 fewer than Proposed Action	1,534 114 fewer than Proposed Action	1,084 45 fewer than Proposed Action	1,017 112 fewer than Proposed Action

For all PFR alternatives, the use, operation, maintenance and repair/replacement of the transmission systems and communication sites would be the same as described for the Proposed Action.

2.3.2.3 Tribal PFR Alternative

The selected quantity of power would be contracted for under long-term power purchase agreement(s) from a new renewable energy facility constructed on lands of a tribe affected by actions under this EIS. Photovoltaic solar was selected over other renewable technologies for evaluation in the EIS because of its relatively low cost, reliability and schedule dependability, wide range of potential siting locations, and demonstrated utility scale capabilities in the region. Energy from photovoltaic solar would be dedicated to meet a portion of CAP demands during daylight hours of 12 hours a day, 7 days a week, a duration which generally corresponds to the period of time that an appropriately size photovoltaic solar facility would be able to reliably meet the 25-MW minimum curtail requirement for NGS and also deliver 100 MW to 250 MW to the CAP during the midday. [12] Energy production from the solar array would ramp up during the morning hours, level out during the middle of the day, and then ramp down during the evening. Similar to the Renewable PFR Alternative, the power purchase agreement for the Tribal PFR Alternative would require firming be included for the defined period of delivery to maintain reliability during short-term fluctuations in output (e.g., cloud cover); however, firming is not intended to augment output from the solar array to achieve a steady 100 MW to 250 MW over the entire period. The net result would be replacement solar power providing an average of between 38 MWH and 94.9 MWH per hour over the course of a 24-hour period.

Energy deliveries from the photovoltaic sources would be monitored over time and curtailment at NGS scheduled to achieve the necessary reduction in NGS production and associated reductions in coal combustion. NGS curtailment would not necessarily be concurrent with the scheduled delivery of energy from the photovoltaic sources to the CAP, however reductions in the amount of power produced at NGS would occur over a yet-to-be determined period of time, i.e., monthly, quarterly or yearly, to total that supplied by renewable sources. Non-concurrent curtailment provides flexibility to optimize operations of NGS, while still assuring achievement of the established levels of emission reductions, and maintains the availability and value of surplus energy from NGS at about the same quantities as under the Proposed Action.

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[12] Based on typical photovoltaic solar productivity in northeastern Arizona over the course of a year, a system with a nominal capacity of 135 MW to 350 MW would be required to deliver 100 MW to 250 MW for several hours during the midday for transmission to the CAP. The differences between the 100 MW to 250 MW and the 135 MW to 350 MW specifications account for the effects of seasonal variation, inverter efficiency when converting power produced by the solar array to the form required for the grid, and meeting NGS operational requirements for curtailment (see **Appendix 2A**).

The Tribal PFR Alternative would reduce net emissions using renewable technology and provide an opportunity for NGS-affected tribes to develop photovoltaic solar capacity, while maintaining the availability and value of surplus energy from NGS at about the same quantities as under the Proposed Action. Based on industry experience, it is reasonable to assume that locating, designing, obtaining all necessary permits and approvals, and constructing a photovoltaic solar facility on tribal land could be accomplished to meet an in-service date of January 2025. For reclaimed lands at the proposed KMC to support a renewable energy facility, a change in the approved post-mining land use from livestock grazing and wildlife habitat to heavy or light industrial uses (solar or wind power facilities) would be necessary. Alternative post mining land uses, including uses for heavy or light industry, for the areas disturbed by mining at the proposed KMC are at the discretion of the Navajo and Hopi Tribes for their respective lands. Alternate uses can be authorized under an active Permit Application Package at the Tribes' request and OSMRE's approval per 30 CFR 816.33. As described in **Table 2A-7** the proposed KMC is not considered a suitable location to supply wind and solar energy to NGS. Federal action(s) associated with development of a photovoltaic solar facility on tribal land would necessitate compliance with the NEPA, Endangered Species Act, and National Historic Preservation Act, as appropriate, before a power purchase agreement would be authorized.

It is assumed that the Tribal PFR Alternative would require new facility construction on one or more sites. Regardless of the facility location(s) ultimately chosen, for purposes of the EIS, the following construction activity and consideration assumptions would apply:

- Land area required, including intertie ROW (5 miles at 100 feet in width): approximately 1,200 (100-MW facility) to 3,000 acres (250-MW facility) acres
- Duration of construction: 18 to 36 months
- Types of construction activities associated with construction of facility:
  - Survey, clear, grub and strip topsoil
  - Site grading and fencing
  - Construct roads and storm water detention
  - Construction foundations and install PV trackers and panels
  - Construct gen-tie line
  - Construct operations and maintenance buildings and substation
  - Construct parking areas and permanent roadways
  - Commission and test
- Project-related traffic:
  - Construction: light duty vehicles (cars and pickups), medium duty truck, semi-tractors and trailers, graders, backhoes, scrapers, compacters, welding rigs, cement delivery trucks, etc.
  - Operation: primarily light and medium duty trucks.
- Project workforce:
  - Construction: 335 to 400 average, higher temporary peaks
  - Operation: 9 – 13
- Water:
  - Construction: approximately 75 to 150 acre-feet during construction (100 MW) and 180 to 375 acre-feet (250 MW), primarily for use in making concrete, for dust suppression, potable use, and other miscellaneous uses.

– Operation: up to 10 acre-feet per year (100 MW) and up to 25 acre-feet per year (250 MW) to clean the PV arrays (to maintain conversion efficiency) and potable use.

The following sections describe how the project component operations and employment (NGS, proposed KMC, and the transmission system) would be modified by the reductions in NGS energy output compared to the Proposed Action. See **Appendix 2A** for detailed description of the Tribal PFR Alternative and the anticipated changes to NGS and associated facilities, the proposed KMC, and transmission system.

2.3.2.3.1 Navajo Generating Station

Table 2-16 provides estimates of NGS and the Tribal PFR Alternative annual energy output, as well as the relative reduction in energy deliveries to CAP (which is offset by energy purchases from a renewable energy source). See the Natural Gas PFR Alternative for how the alternative energy supplied to CAP relates to NGS energy delivery to CAP, and the quantity of NGS energy available for surplus.

Table 2-16 Annual Energy Output for the Tribal PFR Alternative

NGS Configuration	Proposed Action	Tribal PFR 100-MW Reduction	Tribal PFR 250-MW Reduction
NGS – 3-Unit Operation, 547-MW Federal Share			
Federal Energy From NGS (TWh/yr)[1]	4.17	3.83	3.33
Federal Energy Supplied to CAP (TWh/yr)	2.70	2.36	1.86
Energy from PFR source delivered to CAP (TWh/YR)	--	0.33	0.83
NGS Energy Available as Surplus (TWh/yr)	1.47	1.47	1.47
NGS – 2-Unit Operation, 540-MW Federal Share			
Federal Energy From NGS (TWh/yr)	4.12	3.78	3.28
Federal Energy Supplied to CAP from NGS (TWh/yr)	2.70	2.36	1.86
Energy from PFR source delivered to CAP (TWh/YR)	--	0.33	0.83
NGS Energy Available as Surplus (TWh/yr)	1.42	1.42	1.42

[1] TWh/yr = terawatt-hours per year. 1 terawatt equals 1 trillon (1,000,000,000,000) watts.

In **Table 2-17,** an estimate is provided for the number of construction and operations employees that would be required for a new photovoltaic facility constructed on tribal lands. Because a substantially larger number of solar panels and other infrastructure would be required for a 250-MW installation, a larger workforce would be required. **Table 2-17** also provides a general estimate of NGS employment changes under the PFR alternatives relative to the Proposed Action. It is anticipated that slightly fewer employees would be required at NGS in response to lower energy output.

No modifications to NGS coal handling equipment, generation equipment, water delivery, and waste disposal procedures would be required to implement the Tribal PFR Alternative. There would be a reduction in BM&LP Railroad trips, and water and chemical use proportional to the reduced quantity of coal burned for energy generation. These reductions would range from 2 to 8 percent less than under the Proposed Action.

Under the Tribal PFR Alternative, decommissioning and final reclamation of the NGS and BM&LP Railroad would be the same as described for the Proposed Action.

Table 2-17 Regional Employment Associated with NGS Under the Tribal PFR Alternative

Regional Employment	Regional Employment Numbers			
	3-Unit Operation NGS		2-Unit Operation NGS	
	Tribal 100-MW Reduction	Tribal 250-MW Reduction	Tribal 100-MW Reduction	Tribal 250-MW Reduction
New Regional Jobs Related to Alt. Power				
Construction	533 for 1.5 years	636 for 2.5 to 3 years	533 for 1.5 years	636 for 2.5 to 3 years
Operation	9	13	9	13
Total Regional Jobs (direct indirect & induced) – Typical Year	2,125 39 fewer than Proposed Action	2,113 51 fewer than Proposed Action	1,586 30 fewer than Proposed Action	1,568 48 fewer than Proposed Action

2.3.2.3.2 Proposed Kayenta Mine Complex

Table 2-18 provides estimates of reductions in coal mined at the Kayenta Mine under the Tribal PFR Alternative in relation to the Proposed Action. Less reduction in coal mining would occur than under the Natural Gas PFR Alternative because the renewable alternative energy source would not deliver as much energy to CAP, requiring more energy to be delivered from NGS. No modifications to the proposed KMC coal mining and handling equipment, mining procedures and reclamation, groundwater use, and waste disposal procedures would be required to implement the Tribal PFR Alternative. There would be a reduction in energy required to mine coal, and less surface disturbance from mining. On a proportional basis, these reductions would range from 2 to 7 percent less than under the Proposed Action operations.

Table 2-18 Annual Coal Mined for NGS Under for the Tribal PFR Alternative

NGS Configuration	Proposed Action	Tribal PFR 100-MW Reduction	Tribal PFR 250-MW Reduction
NGS – 3-Unit Operation			
Annual Coal Mined (in million tons)	8.1	7.9	7.7
Percentage Difference from Proposed Action [1]	NA	- 2%	- 5%
NGS – 2-Unit Operation			
Annual Coal Mined (in million tons)	5.5	5.3	5.1
Percentage Difference from Proposed Action [1]	NA	- 4%	- 7%

[1] Differences in tons of coal are relative to the base tonnages for the corresponding 3-Unit Operation or 2-Unit Operation under the Proposed Action.

Table 2-19 provides estimates of regional employment changes as the result of less coal mined under this PFR alternative. As indicated in the table, the greatest employment reductions would be associated with the 250-MW energy replacement operation under the 2-Unit NGS Operation.

Table 2-19 Regional Employment Associated with the Proposed KMC Under the Tribal PFR Alternative

	Regional Employment Numbers			
	3-Unit Operation NGS		2-Unit Operation NGS	
	Tribal 100-MW Reduction	Tribal 250-MW Reduction	Tribal 100-MW Reduction	Tribal 250-MW Reduction
Total Regional Jobs (direct indirect & induced) – Typical Year	1,618 30 fewer than Proposed Action	1,566 82 fewer than Proposed Action	1,095 134 fewer than Proposed Action	1,052 177 fewer than Proposed Action

Decommissioning and final reclamation for the proposed KMC would occur as described under the Proposed Action.

2.3.2.3.3 Transmission Systems and Communication Sites

For all PFR alternatives, the use, operation, maintenance and repair/replacement of the transmission systems and communication sites would be the same as described for the Proposed Action. Depending upon where the photovoltaic solar facility required for the Tribal PFR Alternative is located, additional transmission line(s) may need to be constructed to tie into the WTS or STS, which could require another federal action for acquisition of an additional ROW, if federal and tribal lands are involved. Minor modifications of a substation may be required in conjunction with the Tribal PFR Alternative, but no major modifications of the existing WTS and STS would be required.

2.3.3 No Action

2.3.3.1 Navajo Generating Station

Under the No Action Alternative, required federal approvals to extend the operations of the plant beyond December 23, 2019, would not be obtained. Decommissioning activities would begin in 2018 with effective shutdown of the plant occurring by the end of 2019. As provided in the 1969 Lease, if actions are not taken to extend NGS operations, the Lessees would be required to decommission NGS and associated facilities. The 1969 Lease requires that the "surface of any Reservation Lands modified or improved by the Lessees by the construction of access roads, dams, rail transportation facilities, surface pipelines, or other facilities constructed pursuant to this Lease or the [plant site] s 323 Grant" be restored as closely as possible to their original condition. Removal operations and all land surface restorations must be completed by the Lessees no later than December 22, 2020 (see 1969 Lease, Section 12).

The actions required for decommissioning of NGS and associated facilities under the No Action Alternative would be the same as those described under the Proposed Action (Section 2.3.1.1).

The NGS Co-tenants would need to obtain sufficient capacity and baseload energy to replace the amount lost due to the closure of NGS. Each Co-tenant would work independently to develop and secure its replacement resources. Current supply and demand projections for the region suggest that the predominant source of long-term replacement of baseload resources would eventually be the construction of new gas-fired, combined-cycle generation located at low elevations and near existing gas supply lines, transmission systems, water supplies, and the load areas of the Co-tenants. Because of the many variables that each utility would consider in its resource replacement strategy, including compliance and cost of environmental regulations such as the forthcoming ozone standards, it is not possible to accurately predict the location, number, or size of the replacement generating resources. Typically, a combined cycle gas-fired generating station would require a minimum of 4 years to over 6 years to plan, site, permit, and construct. In the interim, each utility would ensure sufficient baseload power resources for their customers through use of their existing generating resources, if available; the acquisition of existing merchant generation capacity; and power purchase agreements, or some combination of such resources. The ability to defer the construction of new replacement resources by utilizing existing resources would be dependent on regional peak capacity and demand conditions. It may be the case that limited excess peak capacity would exist and the construction of new resources would be expedited to ensure grid reliability.

The BM&LP Railroad would be decommissioned by removing the tracks and road bed, and then applying soil to the roadbed, and reseeding. The railroad embankment would not be modified, and would be allowed remain in accordance with the lease provisions (see Proposed Action).

2.3.3.2 Proposed Kayenta Mine Complex

The previously approved LOM plan for the Kayenta Mine would support mining operations through 2026 at the current production rate. However, the NGS presently is the sole commercial customer for the coal mined at the Kayenta Mine. Furthermore, the mine is distant from other existing coal-fired power plants, and those plants have established suppliers. Finally, the BM&LP Railroad that currently transports coal to NGS is not tied into the national rail network and, therefore, would be unable to serve as an initial link to ship coal to other markets. As a result, the potential for PWCC to find another market for its coal is low and the company has indicated it likely would move to close the proposed KMC and proceed to final reclamation of the Kayenta Mine and the former Black Mesa Mine and all support facilities not approved by OSMRE and the Navajo Nation as permanent facilities.

Mine closure and reclamation procedures would be the same as those described for the Proposed Action; however, mine closure and reclamation would take place pursuant to the existing Kayenta Mine permit, and would begin in 2018. Vegetation establishment and final bond release and lease relinquishment could take up to 10 to 15 years after reclamation is complete.

2.3.3.3 Transmission Systems and Communication Sites

The NGS transmission system is an established part of the western U.S. transmission grid and supports reliability and delivery of power throughout the region, well beyond the power generated by the NGS. Therefore, it is likely that that one, several, or all of the land owners/managers of the transmission line rights-of-way and communication site leases would renew some portion of the facilities to keep the power grid performing as expected. Currently, the authorization of the segments on non-tribal lands do not expire until 2022 or later. Additionally, portions of the transmission systems located on private lands have easements that have been granted in perpetuity.

To establish a baseline for comparing impacts against the Proposed Action for purposes of complying with NEPA, following is a description of a No Action Alternative that assumes the required federal approvals for the WTS and STS transmission systems, substations, and communication sites are not granted. All 275 miles of the WTS, 256 miles of the STS (two parallel transmission lines), three substation sites,[13] and two communication sites[14] would be decommissioned, removed, and sites reclaimed according to the land owner/manager's requirements. Decommissioning of these facilities would result in an estimated 4,826 acres of temporary disturbance, based on the following assumptions:

[13] Substations located within facilities shared with other utilities would not be removed nor the area reclaimed.

[14] For communication sites located within shared facilities, decommissioning would consist only of removal of the NGS-related communications equipment.

- Five transmission line tower structures per mile, or 3,935 structures for both the STS and WTS, would be removed. A workspace of one acre per structure would be required to allow large equipment to dismantle the structures, excavate foundations as necessary, and provide laydown areas. A total of 3,935 acres of disturbance would occur, based on these assumptions.
- Additional workspace would be required to remove and coil conductors. This requirement is assumed to be one acre per mile of transmission line, or 787 acres.
- Existing transmission line access roads would be used to the extent practical; however, widening the existing roads and expanding the road system may be required to allow passage of large trucks and equipment such as cranes. There would be a number of acres disturbed from road system expansion that cannot be estimated at this time.
- Nearly all communication sites are currently shared with other operators, and would not be decommissioned. Two communication sites (Zilnez and Glen Canyon) are not shared with others, but occupy less than 1 acre.
- Three STS substations (Yavapai, Cedar Mountain, Dugas) are not shared, and would be decommissioned. The facilities occupy 104 acres within the fence lines. No WTS substations would be decommissioned because they are shared with other operators.

It is likely that, where feasible, above-ground structures would be cut just below ground level and removed; flat areas would be re-contoured to match the natural grade, reseeded, and stabilized for revegetation. To reduce disturbance, subsurface structures would be left in place to the extent practicable. Additional temporary disturbance for reclamation of roads and any temporary storage areas also would occur.

Prior to any decommissioning, a major transmission interconnection study would be required to determine the effects of decommissioning the WTS and STS on the western electric grid, and whether, where, and what replacement facilities would be necessary. The currently unknown number of considerations that must be taken into account and amount of coordination that must occur with other utility and power providers to ensure reliability of the entire western U.S. transmission grid, make it impracticable to identify one or even a range of decommissioning scenarios that could be considered in this EIS in a meaningful way. A lengthy siting and permitting process and construction of replacement facilities prior to decommissioning would likely be required as a separate action.

2.3.3.4 Central Arizona Project

Under the No Action Alternative, NGS power and energy would no longer be available to operate the CAP pumps. As system operator, Central Arizona Water Conservation District would continue to be responsible for obtaining the power necessary to deliver CAP water. Central Arizona Water Conservation District has indicated that it intends to develop a diversified energy portfolio to manage risk and moderate impacts from energy market volatility, if and when NGS is no longer available. Central Arizona Water Conservation District has further indicated its goal is that no individual generation source or contractual supply would make up more than 15 to 20 percent of that portfolio (Central Arizona Water Conservation District 2013).

Under this alternative, Central Arizona Water Conservation District would acquire only enough energy to meet CAP pump loads. There would be no surplus power or energy that could be sold to create revenues for CAP repayment assistance.

Approximately 3.0 million MW-hours of electricity is needed annually to meet CAP pumping requirements (see **Appendix 2A**); this equates to an average hourly power requirement of about 350 MW, which Central Arizona Water Conservation District would meet through baseload resources. While coal, nuclear, and geothermal resources could provide baseload generation, it is anticipated that Central

Arizona Water Conservation District would look to natural gas-fueled generation to meet its baseload power needs for the following reasons:

- Coal. Construction of new coal-fired generation is highly unlikely due to environmental considerations, and it is anticipated that existing coal-fired generation (e.g., NGS) is already fully subscribed or is otherwise unavailable under this alternative.
- Nuclear. All existing nuclear power in the southwest is already fully subscribed, and new nuclear generation would take decades to permit and construct. Small modular reactor technology is under development, but is not anticipated to be commercially available by 2019.
- Geothermal. Geothermal resources are not commercially viable in Arizona (National Renewable Energy Laboratory 2012).
- Natural Gas. Combined Cycle Gas Turbines, could provide baseload generation for CAP. According to information supplied by USEPA in connection with its Clean Power Plan, the current capacity factor of Combined Cycle Gas Turbines located in Arizona is 27 percent. However, it appears that existing Combined Cycle Gas Turbine capacity is fully utilized in the summer months to meet Arizona's peak demands. It also is not clear how the closure of NGS would affect surplus Combined Cycle Gas Turbine capacity after 2019. So while there may be unused Combined Cycle Gas Turbine capacity that could supply a portion of CAP's needs, Central Arizona Water Conservation District may need to construct its own Combined Cycle Gas Turbine facility to obtain a baseload resource for summer months.

The most likely scenario would be one or more power purchase agreements to acquire baseload electrical power from the open market. Based on recent NREL predictions (NREL 2015d), power purchase costs would range from $37.70 to $51.60 per MWH between 2020 and 2025, climbing to between $46.10 and $65.10 per MWH between 2030 and 2044. On an annual basis those costs would translate to total annual energy costs of between $101.6 million and $139.1 million during the 2020 to 2025 time period and between $124.3 million and $175.5 million during the 2030 to 2044 time period. Over the 2020 to 2044 period, the range of energy costs assuming power purchase agreements ranges between $2.93 billion and $4.09 billion, depending on the future price of natural gas.

Central Arizona Water Conservation District may be able to use renewable resources (most likely photovoltaic solar) to supply a minor portion of its energy portfolio, but such resources cannot meet CAP's baseload need because renewable sources are intermittent.

The amount, intensity, and duration of ground disturbance and construction-related noise and traffic would be dependent upon the type of facility being constructed. **Table 2-20** provides some general assumptions of the land and infrastructure requirements needed for a new Combined Cycle Gas Turbine generation facility.

Table 2-20 Assumptions for 350-MW Combined Cycle Natural Gas Turbine Facility Land Requirements, Permitting, and Construction

Activity	Natural Gas Facility	Transmission Line Construction
Land acquisition/zoning/permitting/transmission impact study/contractor selection and award	4 years	6 years
Land clearing and leveling for facility/temporary ROW	60 acres	NA
Total footprint for permanent facility	50 acres	100-foot-wide ROW
Tie-in to existing substation/CAP transmission system (width)	100-foot-wide ROW	100-foot-wide ROW
Duration of construction	3 years	2-3 years

2.3.4 Impact Summary

Table 2-21 provides a summary of the primary environmental and social impacts identified for each resource for each alternative, and the level of impact, ranging from none to major. Impacts are expressed for the NGS-KMC Project as whole, which includes the NGS and associated facilities; BM&LP Railroad; Kayenta Mine, and the Southern and Western Transmission Systems. Impacts have been identified and classified for each project component separately in the resource sections. This table provides an overview of the range of impact levels for the entire project, and then identification of the most important findings. The impact findings included in this summary are derived from the project summaries for each alternative in the resource sections. Due to the nature and extent of the assumptions made to conduct the technical studies which were used to compare the impacts resulting from each alternative, the analyses provide more value as a comparison of each action alternative to the others and to the No Action Alternative's baseline, rather than as a prediction of actual changes that would occur for a particular resource area.

The primary focus of this tabular summary is on impacts that would occur from 2020 through 2044 from the Proposed Action, and how the three partial federal energy replacement alternatives would be similar, or different from the Proposed Action. The No Action summary provides an estimate of the environmental conditions if this project no longer operates after 2019, and begins a decommissioning phase.

A cumulative impact summary is presented for each resource and alternative. The discussion is centered on whether cumulative impacts are anticipated, and if so, the portion of the cumulative impacts contributed by the project, and then an estimate of the total cumulative impact and its importance.

Table 2-21 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.1 Air Quality	The project would be in compliance with national ambient air quality standards, and maximum impacts from both facilities primarily would occur near the sources and decrease with distance. Overall project air quality impacts from 2020 to 2044 (including regional haze and ozone) would be minor to moderate near NGS and the proposed KMC. Source emissions would be reduced by various controls, ranging from stack scrubbers at NGS to watering of haul roads for dust control at the proposed KMC. Deposition of selenium from the proposed KMC would be minor; all other deposition would be negligible. Short-term moderate increases in fugitive dust and equipment emissions would occur during decommissioning over a 1-year period at NGS and a minimum 10-year period at the proposed KMC starting in 2044. In the event some or all of the transmission systems and communication site ROWs (estimated at 4,826 acres) are	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Project compliance with air quality standards would be the same as the Proposed Action. Overall project air quality impacts from 2020 to 2044 (including regional haze and ozone) would be minor to moderate near NGS and the proposed KMC. Stack emissions from NGS would be 5 to 19 percent less, and proposed KMC surface disturbance would be 5 to18 percent less than the Proposed Action. Short-term minor increases in fugitive dust and equipment emissions would occur as described for the Proposed Action decommissioning. WTS and STS operations would continue as described for the Proposed Action. Cumulative impacts would be slightly less than for the Proposed Action, and dominated by non-project activities.	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Project compliance with air quality standards would be the same as the Proposed Action. Overall project air quality impacts from 2020 to 2044 (including regional haze and ozone) would be minor to moderate near NGS and the proposed KMC. Stack emissions from NGS would be 3 to 11 percent less, and proposed KMC surface disturbance would be 3 to10 percent less than the Proposed Action. Short-term minor increases in fugitive dust and equipment emissions would occur as described for the Proposed Action decommissioning. WTS and STS operations would continue as described for the Proposed Action. Cumulative impacts would be slightly less than for the Proposed Action and dominated by non-project activities.	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Air quality impacts would be analyzed in a subsequent NEPA action. Project compliance with air quality standards would be the same as the Proposed Action. Overall project air quality impacts from 2020 to 2044 (including regional haze and ozone) would be minor to moderate near NGS and the proposed KMC. Stack emissions from NGS would be 2 to 8 percent less, and proposed KMC surface disturbance would be 2 to 7 percent less than the Proposed Action. Short-term minor increases in fugitive dust and equipment emissions would occur as described for the Proposed Action decommissioning. WTS and STS operations would be as described for the Proposed Action. Cumulative impacts would be slightly less than for the	NGS stack emissions and Kayenta Mine mining activity emissions would cease in 2019. Air pollutant ground level concentrations would return to background levels. Short-term moderate increases in fugitive dust and equipment emissions would occur during decommissioning operations at both NGS (2018-2019) and the Kayenta Mine (over minimum 10-year period starting in 2019). The NGS transmission system is an established part of the western U.S. transmission grid and supports reliability and delivery of power throughout the region, beyond the power from NGS. Under the No Action Alternative, it is likely that that one, several, or all of the land owners/managers of the transmission line ROWs and communication site leases would renew all or part of the facilities to maintain expected power grid performance. In the event some or all of the transmission systems and communication site ROWs (estimated at 4,826 acres total) are not renewed, a lengthy

Table 2-21 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.1 Air Quality (continued)	not renewed/decommissioned, a lengthy study and permitting process, and construction of replacement facilities, would precede any decommissioning due to the essential and integral nature of these facilities with the western electric grid. Cumulative impacts regionally (within 300 km of NGS) would be major for ozone, and minor to major for acid deposition due to the additive effects of NGS and other sources. Maximum cumulative criteria pollutant impacts would be minor. Cumulative regional haze would be moderate.			Proposed Action and dominated by non-project activities.	study and permitting process, and construction of any replacement facilities, would precede any decommissioning due to the essential and integral nature of these facilities with the western electric grid.
3.2 Climate and Climate Change	Future Project greenhouse gas emissions are estimated to range between 18.4 (3-unit) and 12.3 (2-unit) million metric tons per year over the period 2020-2044. Over this time frame, it is estimated that global greenhouse gas emissions would increase 52 percent because of increased energy demands, a major [cumulative] impact. Because NGS-KMC Project's greenhouse emissions would be constant, they would represent a declining share of the overall global increase.	Future Project greenhouse gas emissions are estimated to range between 17.9 and 17.1 (3-unit) and 11.8 and 11.0 (2-unit) million metric tons per year over the period 2020-2044. These emissions represent a 12 to 30 percent greenhouse gas reduction relative to the Proposed Action because natural gas-generated energy purchased from the market would be substituted for coal combustion at NGS.	Future Project greenhouse gas emissions are estimated to range between 17.9 and 17.1 (3-unit) and 11.8 and 11.0 (2-unit) million metric tons per year over the period 2020-2044. These emissions represent a 12 to 30 percent greenhouse gas reduction relative to the Proposed Action because renewable source-generated energy purchased from the market would be substituted for coal combustion at NGS.	Future Project greenhouse gas emissions are estimated to range between 18.1 and 17.6 (3-unit) and 12.0 and 11.5 (2-unit) million metric tons per year over the period 2020-2044. These emissions represent an 8 to 19 percent greenhouse gas reduction relative to the Proposed Action because renewable energy, generated from a photovoltaic solar facility on tribal land, would be substituted for coal combustion at NGS.	After NGS and the Kayenta Mine cease operations in 2019 under the 1969 lease and other existing arrangements, it is assumed that federal share replacement power for the CAP system would be provided by a natural gas combined cycle source. On this basis, 8.6 metric tons of greenhouse gases would be emitted, or 53 percent less than the Proposed Action 3-unit operation, and 30 percent less than the Proposed Action 2-unit operation.

Table 2-21 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.3 Geology	NGS and proposed KMC components and operations would not impact unique geologic features and would be exposed to minor risk from damage during an earthquake event from 2020 through 2044. Mining at proposed KMC and coal combustion disposal would result in minor impact to land forms. The WTS and STS would continue operations as described under the Air Quality Proposed Action and no impacts to unique geologic resources are anticipated. The WTS would be at minor risk of damage from earthquakes because of its proximity to active faults and higher potential ground motion during an earthquake.	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Impacts to unique geologic resources, land forms, and as a result of geologic hazards would be the same as the Proposed Action, except that 5 to 18 percent less mining surface disturbance would occur at the proposed KMC, resulting in less impact to land forms.	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Impacts to unique geologic resources, land forms, and as a result of geologic hazards would be the same as the Proposed Action, except that 3 to 10 percent less mining surface disturbance would occur at the proposed KMC, resulting in less impact to land forms.	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Geology resource impacts would be analyzed in a subsequent NEPA action. Impacts to unique geologic resources, land forms, and as a result of geologic hazards would be the same as the Proposed Action, except that 2 to 7 percent less mining surface disturbance would occur at the proposed KMC, resulting in less impact to land forms.	Demolition and mine closure after 2019 would have no impact to unique geologic resources and negligible impacts to land forms as a result of reclamation activities. Impacts to the WTS and STS are the same as described for the Air Quality No Action Alternative. The WTS would be at minor risk of damage from earthquakes because of its proximity to active faults and higher potential ground motion during an earthquake.
3.4 Minerals	Negligible project impacts to mineral resource availability because of the absence of known commercially extractable minerals except for coal at the proposed KMC. Coal resources at the proposed KMC would be adequate to meet NGS power generation commitments. The WTS and STS would	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Mineral resource occurrence and availability impacts would be the same as the Proposed Action, except that 5 to 18 percent less mining surface disturbance would occur at the proposed KMC.	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Mineral resource occurrence and availability impacts would be the same as the Proposed Action, except that 3 to 10 percent less mining surface disturbance would occur at the proposed KMC.	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Mineral resource impacts would be analyzed in a subsequent NEPA action. Mineral resource occurrence and availability impacts would be the same as the Proposed Action, except that 2 to 7	Negligible impacts on mineral resources from decommissioning at NGS, BM&LP Railroad, and the Kayenta Mine after 2019. Impacts as described in the Proposed Action would not occur because coal extraction from 5,230 to 4,741 acres at Kayenta Mine after 2019 would not occur.

Table 2-21 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.4 Minerals (continued)	continue operations as described under the Air Quality Proposed Action.			percent less mining surface disturbance would occur at the proposed KMC.	Impacts to the WTS and STS are the same as described for the Air Quality No Action Alternative.
3.5 Paleonto-logical	Negligible project surface disturbance impacts to fossil resources because of the generally low to moderate fossil importance rank of the bedrock formations, and the recommended unanticipated discovery protection measure at proposed KMC. The WTS and STS would continue operations as described under the Air Quality Proposed Action.	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Paleontological resource impacts would be the same as the Proposed Action, except that 5 to 18 percent less mining surface disturbance would occur at the proposed KMC.	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Paleontological resource impacts would be the same as the Proposed Action, except that 3 to 10 percent less mining surface disturbance would occur at the proposed KMC.	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Paleontological resource impacts would be analyzed in a subsequent NEPA action. Paleontological resource impacts would be the same as the Proposed Action, except that 2 to 7 percent less mining surface disturbance would occur at the proposed KMC.	Negligible impacts on paleontological resources from decommissioning NGS, BM&LP Railroad, and the Kayenta Mine after 2019. Impacts as described in the Proposed Action would not occur because coal extraction from 5,230 to 4,741 acres at Kayenta Mine after 2019 would not occur. Impacts to the WTS and STS are the same as described for the Air Quality No Action Alternative.

Table 2-21 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.6 Soil	Moderate project soil surface disturbance impacts from 2020 to 2044 would range from 4,998 to 5,527 acres. Soils and suitable revegetation material would be salvaged and protected in accordance with federal regulatory programs and lease terms. Minor trace metal deposition impacts. Predicted trace metal deposition would not cause applicable EPA soil screening levels to be exceeded or contribute to unacceptable human or ecological risks. After 2044, 10,123 acres on NGS, the BM&LP Railroad, and the proposed KMC would require reapplication of soil or suitable revegetation materials and seeded. The WTS and STS would continue operations as described under the Air Quality Proposed Action. Proposed Action contributes 7 to 8 percent to estimated cumulative soil disturbance of 61,985 to 62,514 acres, a moderate cumulative impact.	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Moderate project soil disturbance impacts from 2020 to 2044 would be 5 to 18 percent less than the Proposed Action because less coal would be mined. Minor trace metal deposition impacts would be 5 to 19 percent less than the Proposed Action. Decommissioning after 2044 also would be proportionally less. Cumulative impacts slightly less than Proposed Action.	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Moderate project soil disturbance impacts from 2020 to 2044 would be 3 to 10 percent less than the Proposed Action because less coal would be mined. Minor trace metal deposition would be 2 to 12 percent less than the Proposed Action. Decommissioning after 2044 also would be proportionally less. Cumulative impacts slightly less than Proposed Action.	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Soil resource impacts would be analyzed in a subsequent NEPA action. Moderate project soil disturbance impacts from 2020 to 2044 would be 2 to 7 percent less than the Proposed Action because less coal would be mined. Minor trace metal deposition impacts would be 2 to 11 percent less than the Proposed Action. Decommissioning after 2044 also would be proportionally less. Cumulative impacts slightly less than Proposed Action.	Demolition and mine closure after 2019 would require topsoiling and seeding on 9,272 acres. Impacts to the WTS and STS are the same as described for the Air Quality No Action Alternative. Soil protection, and erosion and sediment control programs, and transmission line and communication site operation and maintenance activities would be the same as those described for the Proposed Action. Impacts to the WTS and STS are the same as described for the Air Quality No Action Alternative.

Table 2-21 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.7 Water	Moderate to negligible project impacts from 2020 to 2056 to surface water and groundwater water quantity and quality. Moderate impacts include modifications in surface flows in major washes downstream from the proposed KMC caused by changes in location and capacity of storage ponds. Minor project impacts include mine pumping drawdown of N-Aquifer utilized by nearby community wells, increases in community well pumping costs; and changes in water levels in the Wepo aquifer that may affect community surface water uses, and water quality. The Project is projected to contribute minor reductions in future N-Aquifer drawdown, but cumulative drawdown from all sources is predicted to be major (see No Action). The WTS and STS would continue operations as described under the Air Quality Proposed Action.	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Moderate and minor project impacts from 2020 to 2044 would be the same as the Proposed Action except that 5 to 18 percent less mining surface disturbance would occur at the proposed KMC, which may modify plans for stormwater retention. Proposed KMC groundwater pumping demands would remain the same. Cumulative impacts would be similar to the Proposed Action.	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Moderate and minor project impacts from 2020 to 2044 would be the same as the Proposed Action except that 3 to 10 percent less mining surface disturbance would occur at the proposed KMC, which may modify plans for stormwater retention. Proposed KMC groundwater pumping demands would remain the same. Cumulative impacts would be similar to the Proposed Action.	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Water resource impacts would be analyzed in a subsequent NEPA action. Moderate and minor project impacts from 2020 to 2044 would be the same as the Proposed Action except that 2 to 7 percent less mining surface disturbance would occur at the proposed KMC, which may modify plans for stormwater retention. Proposed KMC groundwater pumping demands would remain the same. Cumulative impacts would be similar to the Proposed Action.	By ceasing Kayenta Mine operations in 2019, mine drawdown impacts on nearby community wells and pumping costs would be negligible. Major to moderate N-Aquifer water level impacts are predicted as the result of community pumping through 2057 when up to 150 feet of drawdown is predicted. Major baseflow declines in Chinle Creek, Laguna Creek, and Polacca Wash would largely result from projected community pumping. Simulated reductions in flow at both monitored and non-monitored springs also are predicted to result from increases in community pumping over time. Impacts to the WTS and STS are the same as described for the Air Quality No Action Alternative.

Table 2-21 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.8 Vegetation	Moderate to negligible project impacts on vegetation. Moderate project vegetation removal impacts from 2020 to 2044 would range from 4,998 to 5,527 acres. Disturbed areas would be reseeded with approved mixtures, and monitored for release back to the Navajo Nation and Hopi Tribe. Re-establishment of grassland communities would require 5 years; shrublands and woodlands from 25 to 50 years. Minor project impacts from noxious weeds which could quickly expand across disturbed areas. Weed populations would be targets of ongoing control during reclamation. After 2044, 10,123 acres of project surface disturbance would require reapplication of soil followed by reseeding, and approved for release to the land owner. The WTS and STS would continue operations as described under the Air Quality Proposed Action. Project vegetation removal	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Moderate project vegetation removal impacts from 2020 to 2044 would be 5 to 18 percent less than the Proposed Action because less coal would be mined; decommissioning requirements also would be proportionally less. Moderate cumulative vegetation removal impacts would be slightly less than the Proposed Action because of less surface disturbance on the proposed KMC.	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Moderate project vegetation removal impacts from 2020 to 2044 would be 3 to 10 percent less than the Proposed Action because less coal would be mined; decommissioning requirements after 2044 would be proportionally less. Moderate cumulative vegetation removal impacts would be slightly less than the Proposed Action because of less surface disturbance on the proposed KMC.	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Vegetation resource impacts would be analyzed in a subsequent NEPA action. Moderate project vegetation removal impacts from 2020 to 2044 would be 2 to 7 percent less than the Proposed Action because less coal would be mined; decommissioning requirements after 2044 also would be proportionally less. Moderate cumulative vegetation removal impacts would be slightly less than the Proposed Action because of less surface disturbance on the proposed KMC.	Demolition and mine closure after 2019 would require seeding on 9,272 acres. Seeding requirements would be the same as those for the Proposed Action. Negligible impacts to native riparian communities in major washes near Kayenta Mine from community pumping because of predicted reductions in baseflows, Primary areas of concern are Chinle Creek, Laguna Creek, and Polacca Wash, where native riparian vegetation communities are not present, or are extremely small and isolated. Impacts to the WTS and STS are the same as described for the Air Quality No Action Alternative.

Table 2-21 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.8 Vegetation (continued)	impacts from 2020-2044 would contribute 7 to 8 percent of up to 61,985 to 62,514 acres of moderate cumulative vegetation removal impacts.				
3.9 Special Status Vegetation Resources	Negligible project impacts on special status plants. Negligible potential surface disturbance impacts to special status plants from O&M activities in transmission line ROW; negligible loss of special status plants and populations from project new surface disturbance, and N-Aquifer drawdown. The WTS and STS would continue operations as described under the Air Quality Proposed Action. Minor cumulative risks for loss of special status plants from foreseeable utility construction activities adjacent to, or near the WTS ROW.	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Negligible project impacts on special status plants. Minor cumulative risks for loss of special status plants from foreseeable utility construction activities adjacent to, or near the WTS ROW.	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Negligible project impacts on special status plants. Minor cumulative risks for loss of special status plants from foreseeable utility construction activities adjacent to, or near the WTS ROW.	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Special status vegetation impacts would be analyzed in a subsequent NEPA action. Negligible project impacts on special status plants. Minor cumulative risks for loss of special status plants from foreseeable utility construction activities adjacent to, or near the WTS ROW.	Impacts to the WTS and STS are the same as described for the Air Quality No Action Alternative. O&M activities would occur along transmission line access roads, and periodic repairs may be required. Negligible risk of special status plant disturbance.
3.10 Terrestrial Wildlife	Moderate to negligible impacts to wildlife habitat and populations. Moderate impacts on wildlife habitat from vegetation removal; moderate impacts from direct losses of individuals from collisions, and electrocution; habitat avoidance impacts from human activities	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Moderate habitat removal impacts from 2020 to 2044 would be 5 to 18 percent less than the Proposed Action	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Moderate habitat removal impacts from 2020 to 2044 would be 3 to 10 percent less than the Proposed Action	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Terrestrial wildlife impacts would be analyzed in a subsequent NEPA action. Moderate habitat removal	From 4,998 to 5,527 acres of shrubland and woodland vegetation at NGS and Kayenta Mine would not be removed by coal mining. Impacts to the WTS and STS are the same as described for the Air Quality No Action

Table 2-21 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.10 Terrestrial Wildlife (continued)	at the proposed KMC (traffic, lighting, noise). The WTS and STS would continue operations as described under the Air Quality Proposed Action. Moderate cumulative impacts due to regional habitat removal, foreseeable construction near the WTS.	because less coal would be mined. Direct animal losses and human activity levels would be the same as the Proposed Action. Moderate cumulative impacts would be slightly less than the Proposed Action because of reduced mining surface disturbance (see Vegetation).	because less coal would be mined. Direct animal losses and human activity levels would be the same as the Proposed Action. Moderate cumulative impacts would be slightly less than the Proposed Action because of reduce mining surface disturbance (see Vegetation).	impacts from 2020 to 2044 would be 2 to 7 percent less than the Proposed Action because less coal would be mined. Direct animal losses and human activity levels would be the same as the Proposed Action. Moderate cumulative impacts would be slightly less than the Proposed Action because of reduce mining surface disturbance (see Vegetation).	Alternative.
3.11 Special Status Wildlife Resources	Minor project impacts to individuals of the Mexican spotted owl from mining-related noise and lighting; minor impacts to Mojave and Sonoran desert tortoise from vehicle collisions during WTS and STS O&M activities. The WTS and STS would continue operations as described under the Air Quality Proposed Action. Cumulative effects minor to moderate on Mojave desert tortoise, southwest willow flycatcher, and yellow-billed cuckoo due to foreseeable transmission line and water pipeline construction.	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Minor project impacts to special status species, same as Proposed Action. Cumulative impacts to the Mexican Spotted Owl, Mojave Desert Tortoise, Southwestern Willow Flycatcher, and yellow-billed Cuckoo would be same as the Proposed Action.	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Minor project impacts to special status species, same as Proposed Action. Cumulative impacts to the Mexican Spotted Owl, Mojave Desert Tortoise, Southwestern Willow Flycatcher, and yellow-billed Cuckoo would be same as the Proposed Action.	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Special status wildlife impacts would be analyzed in a subsequent NEPA action. Minor project impacts to special status species, same as Proposed Action. Cumulative impacts to the Mexican Spotted Owl, Mojave Desert Tortoise, Southwestern Willow Flycatcher, and yellow-billed Cuckoo would be same as the Proposed Action.	From 4,998 to 5,527 acres of shrubland and woodland vegetation at NGS and Kayenta mine would not be removed by coal mining, resulting in lower human activity impacts on the Mexican spotted owl. Vehicle collisions risk for Mojave and Sonoran Desert Tortoise would be same because foreseeable construction projects adjacent to the WTS would likely occur; Impacts to the WTS and STS are the same as described for the Air Quality No Action Alternative. O&M activities along the WTS and STS would continue, unless full decommissioning occurs.

Table 2-21 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.12 Aquatic Biological Resources	Minor to negligible NGS trace metal deposition impacts on aquatic community constituents and water quality. The combination of baseline concentrations with very small project contributions would result in a minor risk of selenium effects on fish populations in the San Juan River and the Colorado River below Glen Canyon Dam. Minor impacts to aquatic species due to elevated metals concentrations that exceed toxicity thresholds in proposed KMC surface waterbodies, primarily from background sources. Groundwater pumping for the proposed KMC Proposed Action would contribute less than 1 percent reduction in Begashibito Wash, resulting in minor changes in aquatic habitat where surface flows are present. The WTS and STS would continue operations as described under the Air Quality Proposed Action. NGS future operations would	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. NGS trace metal impacts would be the same as the Proposed Action, except NGS stack emissions would be 5 to 19 percent less. Cumulative impacts from trace metals deposition, and cumulative groundwater pumping impacts on aquatic habitats would be the same as the Proposed Action.	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. NGS trace metal impacts on fisheries would be the same as the Proposed Action, except NGS stack emissions would be 3 to 11 percent less. Cumulative impacts from trace metals deposition, and cumulative groundwater pumping impacts on aquatic habitats would be the same as the Proposed Action.	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Aquatic biological resource impacts would be analyzed in a subsequent NEPA action. NGS trace metal impacts on fisheries would be the same as the Proposed Action, except NGS stack emissions would be 2 to 8 percent less. Cumulative impacts from trace metals deposition, and cumulative groundwater pumping impacts on aquatic habitats would be the same as the Proposed Action.	The elimination of current NGS emissions would subtract a very small emission level from existing baseline conditions. There would be continued minor deposition impacts from mercury and selenium in the Colorado River below Glen Canyon Dam, and selenium in the San Juan River on some nongame fish species. Because the elimination of emission effects from the proposed KMC facilities would be very small, the resulting metal concentrations in waterbodies would be negligible. Continued minor impacts to aquatic species due to elevated metals concentrations that exceed toxicity thresholds in Kayenta Mine surface waterbodies, primarily from background sources. Community pumping would result in base flow reductions of approximately 8 to 22 percent in Polacca, Chinle, and Begashibito washes and Laguna Creek, which would cause moderate reductions in aquatic habitat and aquatic invertebrates where surface water is present. Impacts to the WTS and STS

Table 2-21 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.12 Aquatic Biological Resources (continued)	contribute a small fraction of the total cumulative fish tissue concentrations. Cumulative deposition of mercury and selenium in the Colorado River below Glen Canyon Dam and in the San Juan River present a potential risk to fish populations. Global and other regional sources are the main contributors to metal effects.				are the same as described for the Air Quality No Action Alternative.
3.13 Special Status Aquatic Biological Species	Minor trace metal deposition impacts based on the low number of fish that could be injured and the small percentage of fish population numbers potentially affected. Minor project impacts (measured by tissue concentrations) to fish individuals of Colorado pike minnow, razorback sucker, and humpback chub from NGS trace metal contributions combined with baseline concentrations. Minor impacts on critical habitat for Colorado pikeminnow and razorback sucker in the San Juan River and humpback chub and razorback sucker in the Colorado River below Glen Canyon Dam, because of historical small baseline exceedances of mercury and selenium water quality	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. NGS trace metal impacts would be the same as the Proposed Action, except NGS stack emissions would be 5 to19 percent less. Cumulative impacts from trace metals deposition would be nearly the same as the Proposed Action.	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. NGS trace metal impacts would be the same as the Proposed Action, except NGS stack emissions would be 3 to 11 percent less. Cumulative impacts from trace metals deposition would be nearly the same as the Proposed Action.	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Special status aquatic biological resource impacts would be analyzed in a subsequent NEPA action. NGS trace metal impacts would be the same as the Proposed Action, except NGS stack emissions would be 2 to 8 percent less. Cumulative impacts from trace metals deposition would be nearly the same as the Proposed Action.	Elimination of current NGS emissions after 2019 would subtract a very small emission level from existing baseline conditions. Potential risks to special status species would occur in the Colorado River below Glen Canyon Dam and San Juan River due to baseline fish tissue concentrations. There would be a minor effect on the water element of critical habitat for humpback chub and razorback sucker in the Colorado River below Glen Canyon Dam and Colorado pikeminnow and razorback sucker in the San Juan River, based on historical exceedances of mercury or selenium water quality standards. Impacts to the WTS and STS are the same as described for the Air Quality No Action

Table 2-21 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.13 Special Status Aquatic Biological Species (continued)	standards. The WTS and STS would continue operations as described under the Air Quality Proposed Action. Minor cumulative impacts (based on life stage injury estimates) of mercury to individuals of Colorado pikeminnow in the San Juan River; moderate impacts of mercury on humpback chub individuals and critical habitat in the Colorado River below Glen Canyon Dam; moderate impacts to razorback sucker individuals and critical habitat in the Colorado River below Glen Canyon Dam and in the San Juan River. Project emissions contributions to mercury concentrations in fish tissue are estimated to be 0.1 to 0.2 percent.				Alternative.
3.14 Land Use	Moderate project land use impacts, almost entirely from continued mining on proposed KMC. Vegetation removal impacts from 2020 to 2044 would range from 4,998 to 5,527 acres. Area of surface disturbance requiring reclamation after 2044 is 10,123 acres. Disturbed areas would be reseeded with	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Moderate project land use impacts would be the same as the Proposed Action except that 5 to 18 percent less surface disturbance at the	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Moderate project land use impacts would be the same as the Proposed Action except that 3 to 10 percent less surface disturbance at the	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Land use impacts would be analyzed in a subsequent NEPA action. Moderate project land use impacts would be the same as	From 4,998 to 5,527 acres of shrubland and woodland vegetation at NGS and Kayenta Mine would not be removed by coal mining, and would be available for grazing and other uses. Once decommissioning and reclamation activities are complete after 2019, the NGS site, BM&LP Railroad ROW, and Kayenta Mine would be

Table 2-21 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.14 Land Use (continued)	approved mixtures, and monitored for release back to the Navajo Nation and Hopi Tribe. Incremental reduction or removal of four to five grazing areas would reduce livestock grazing capacity. Residential relocations from mining areas would be a moderate impact because the residents are compensated.	proposed KMC would occur because less coal would be mined, which may change number of residents that would require relocation.	proposed KMC would occur because less coal would be mined, which may change number of residents that would require relocation.	the Proposed Action except that 2 to 7 percent less surface disturbance at the proposed KMC would occur because less coal would be mined, which may change number of residents that would require relocation.	returned to the Navajo Nation and Hopi Tribe. Impacts to the WTS and STS are the same as described for the Air Quality No Action Alternative.
3.15 Public Safety	Minor to negligible project public safety impacts because the public is excluded from the industrial activity areas of the NGS and the proposed KMC. Residents within the proposed KMC lease boundary would be exposed to equipment noise, periodic blasting, mine traffic, and potential hazardous spills Planning and implementation of best management practices would reduce impacts from potential spills. Notice of blasting activity is provided in advance and residential relocation programs are initiated when mining encroaches within the safety zone around residences. The WTS and STS would continue operations as described under the	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Minor to negligible project public safety impacts would be the same as the Proposed Action except that 5 to 18 percent less surface disturbance at proposed KMC would occur because less coal would be mined, which may change the number of residents that would require relocation, and change the residence exposure distance to potential spills, noise and fugitive dust sources.	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Minor to negligible project public safety impacts would be the same as the Proposed Action except that 3 to 10 percent less surface disturbance at proposed KMC would occur because less coal would be mined, which may change the number of residents that would require relocation, and change the residence exposure distance to potential spills, noise and fugitive dust sources.	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Public safety impacts would be analyzed in a subsequent NEPA action. Minor to negligible project public safety impacts would be the same as the Proposed Action except that 2 to 7 percent less surface disturbance at proposed KMC would occur because less coal would be mined, which may change the number of residents that would require relocation, and change the residence exposure distance to potential spills, noise and fugitive dust sources.	Mine reclamation activities would continue after 2019, but no active surface mining. Residential relocations, noise disturbance, and other impacts as described in the Proposed Action and action alternatives in the proposed mining areas would not occur.

Table 2-21 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.15 Public Safety (continued)	Air Quality Proposed Action.				
3.16 Public Health and Human Health Risk	Human health risks from project component emissions are negligible because potential cancer and non-cancer risks are considered acceptable based on human health risk assessments. Project operations would result in minor or negligible health impacts to the general population. Major project benefits to public health result from long-term employment at NGS and the proposed KMC and opportunities for health care. These benefits are offset by minor emotional stress caused by relocation of residents and the indirect health effects associated with proximity to mining noise and equipment activity. The WTS and STS would continue operations as described under the Air Quality Proposed Action. Based on an unacceptable non-cancer hazard of 2 for the ingestion of Lake Powell fish by the recreational user, a minor	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Negligible project human health risks and minor to negligible health impacts would be the same as the Proposed Action except that 5 to 18 percent less surface disturbance would occur because of less coal mining, resulting in less exposure to fugitive dust over the long term. Minor Lake Powell fish ingestion hazards would be the same as the Proposed Action.	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Negligible project human health risks and minor to negligible health impacts would be the same as the Proposed Action except that 3 to 10 percent less surface disturbance would occur because of less coal mining, resulting in less exposure to fugitive dust over the long term. Minor Lake Powell fish ingestion hazards would be the same as the Proposed Action.	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Impacts to public health and human health risks would be analyzed in a subsequent NEPA action. Negligible project human health risks and minor to negligible health impacts would be the same as the Proposed Action except that 2 to 7 percent less surface disturbance would occur because of less coal mining, resulting in less exposure to fugitive dust over the long term. Minor Lake Powell fish ingestion hazards would be the same as the Proposed Action.	Human exposure to NGS stack emissions would cease after 2019. Dust emissions from decommissioning and reclamation activities at NGS would occur over a 1-year period, and over a minimum of 10 years at the Kayenta Mine, a negligible human health impact. Closure of the Kayenta Mine after 2019 would eliminate public exposure to mine traffic, equipment noise, and blasting. The loss of jobs at both NGS and the Kayenta Mine would result in increased stress for unemployed workers and their families and potential loss of health benefits. This constitutes a major impact on public health. Minor Lake Powell fish ingestion hazards would be the same as the Proposed Action. Impacts to the WTS and STS are the same as described for the Air Quality No Action Alternative.

Table 2-21 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.16 Public Health and Human Health Risk (continued)	impact on human health was identified. The impact is considered minor because of the fish advisory (Arizona Game and Fish Department 2012) that likely limits the consumption of fish. NGS trace metal contributions to this hazard would be negligible.				
3.17 Cultural Resources	Major to negligible impacts to cultural resources from surface mining at the proposed KMC. Moderate to major impacts from discovery and repatriation of human burials within areas to be mined; moderate impacts to archeological and architectural sites; negligible to major impacts to Traditional Cultural Properties, which are places important for traditional uses or religious values. Cultural resources potentially directly affected consist of 195 to 214 archaeological sites. 15 Traditional Cultural Properties; and 13 human remains. Two Programmatic Agreements developed for the NGS-KMC Project address cultural resource impacts for all project components and direct the responsible federal agencies to consult with federal, state, Tribal, municipal, and private landowners to address Section	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Major to negligible impacts to cultural resources from surface mining at proposed KMC. Direct impacts to cultural resources would be similar to the Proposed Action, but cannot be quantified because specific future mining plans have not yet been developed. Negligible to major cumulative risks for cultural resource disturbance from foreseeable utility construction activities adjacent to, or near the WTS ROW.	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Major to negligible impacts to cultural resources from surface mining at the proposed KMC. Direct impacts to cultural resources would be similar to the Proposed Action, but cannot be quantified because specific future mining plans have not yet been developed. Negligible to major cumulative risks for cultural resource disturbance from foreseeable utility construction activities adjacent to, or near the WTS ROW.	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Cultural resource impacts would be analyzed in a subsequent NEPA action. Major to negligible impacts to cultural resources from surface mining at the proposed KMC. Direct impacts to cultural resources would be similar to the Proposed Action, but cannot be quantified because specific future mining plans have not yet been developed. Negligible to major cumulative risks for cultural resource disturbance from foreseeable utility construction activities adjacent to, or near the WTS ROW.	Project impacts to historic properties listed in or potentially eligible for listing in the NRHP would not occur. Potential impacts to cultural resources of any type would take place during the decommissioning phase of the project. Any future undertakings, such as decommissioning and reclamation, would be addressed through the standard regulatory process (36 CFR 800) by the appropriate federal agency. Impacts to the WTS and STS are the same as described for the Air Quality No Action Alternative.

Table 2-21 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.17 Cultural Resources (continued)	106 requirements. The WTS and STS would continue operations as described under the Air Quality Proposed Action. Negligible to major cumulative risks for cultural resource disturbance from foreseeable utility construction activities adjacent to or near the WTS ROW.				
3.18 Socio-economics	Major economic impacts are associated with the continuation of the NGS-KMC Project. These include providing 2,745 to 3,812 jobs, approximately 187 to 260 million dollars in labor income, and estimated project-related payments to tribes of 1.8 to 2.5 billion over the 25-year period. A continued employment base would provide long-term social stability, and allow the younger generation members to remain in their communities. Concerns about the long-term commitment to coal as a source of electrical energy, public health, water supply availability, residential relocations, and grazing land availability would	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Major economic impacts are associated with continuation of the NGS-KMC Project. NGS and proposed KMC employment and labor income would be between 4 and 10 percent lower compared to the Proposed Action. These labor income and employment reductions would be major impacts because of the lack of revenue replacement opportunities. Project operations would provide long-term social stability, and concerns about commitment to coal as an	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Major economic impacts are associated with continuation of the NGS-KMC Project. NGS and proposed KMC employment and labor income would be between 3 and 6 percent lower compared to the Proposed Action. These labor income and employment reductions would be major impacts because of the lack of revenue replacement opportunities. Project operations would provide long-term social stability, and concerns about commitment to coal as an	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Socioeconomic impacts would be analyzed in a subsequent NEPA action. Major economic impacts are associated with continuation of the NGS-KMC Project. NGS employment and labor income would be between 3 and 7 percent lower compared to the Proposed Action. These labor income and employment reductions would be major impacts because of the lack of revenue replacement opportunities. Short-term employment (1 to 3 years) providing 550 to 650 construction jobs would provide	Major economic and social impacts would occur if NGS and the Kayenta Mine ceased operations after 2019. It is estimated that 3,090 jobs would be immediately lost, with a reduction in labor income of $234 million per year, as well as long-term retirement and pension income. Community contributions and scholarships provided by NGS and Kayenta Mine operators of approximately $700,000 per year; payments to the Navajo electrical utility; and PWCC contributions to abandoned mine and black lung funds would cease. Fiscal impacts would be major because of the very large contribution of NGS and the

Table 2-21 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.18 Socio-economics (continued)	continue. The WTS and STS would continue operations as described under the Air Quality Proposed Action. Pumping energy costs to CAP are expected to increase by 20 to 23 percent, as compared to 2016 base rate of $76 per acre-foot of water delivered (Agricultural Settlement Pool). This increase is considered a minor to moderate impact to agricultural water users. The contributions of the project to cumulative socioeconomic effects would be moderate to major because the incomes for residents and payments to the Navajo Nation and Hopi are substantial and would provide a measure of revenue stability at a time when revenues from other sources may decline.	energy source, and impacts to public health and land use would continue. Pumping energy costs to CAP would increase by between 45 and 112 percent as compared to 2016 base rate of $76 per acre-foot of water delivered (Agricultural Settlement Pool). This increase is considered a moderate to major impact to users. The contributions of the project to cumulative socioeconomic impacts would be moderate to major, same as the Proposed Action.	energy source, and impacts to public health and land use would continue. Pumping energy costs to CAP would increase by between 36 and 68 percent as compared to 2016 base rate of $76 per acre-foot of water (Agricultural Settlement Pool). This increase is considered a minor to major impact to users. The contributions of the project to cumulative socioeconomic impacts would be moderate to major, same as the Proposed Action.	a minor income and employment benefit. Project operations would provide long-term social stability, and concerns about commitment to coal as an energy source, and impacts to public health, cultural resources, and land use would continue. Pumping energy costs to CAP would increase by between 36 and 68 percent as compared to 2016 base rate of $76 per acre-foot of water delivered (Agricultural Settlement Pool). This increase is considered a minor to major impact to users. The contributions of the project to cumulative socioeconomic impacts would be moderate to major, same as the Proposed Action.	Kayenta Mine to the Navajo and Hopi government revenues, and the high proportion of tribal workers at both facilities. Rising unemployment would likely require many workers and their families to leave Page, Kayenta, and other nearby Navajo chapters for employment opportunities elsewhere. Economic hardship for local business would likely increase from the loss of power plant and mine employment. Project-related concerns about public health, cultural resources, and land use would diminish. Pumping energy costs to CAP could result in energy costs between 19 percent lower and 18 percent more costly as compared to 2016 base rate of $76 per acre-foot of water delivered (Agricultural Settlement Pool). This range is largely dictated by changes in natural gas prices. Costs of agricultural production may increase, resulting in less income to farmers. No excess generation income would be provided by NGS, and therefore

Table 2-21 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.18 Socio-economics (continued)					no contributions to the Development Fund. Impacts to the WTS and STS are the same as described for the Air Quality No Action Alternative.
3.19 Environmental Justice	Residents living within and immediately adjacent to the proposed KMC who are part of the Environmental Justice population on the Navajo Nation would experience disproportionately high sociocultural impacts and minor to moderate human health impacts. No disproportionately high and adverse sociocultural or human health impacts to any other environmental justice populations would be anticipated. The WTS and STS would continue operations as described under the Air Quality Proposed Action. No disproportionately high and adverse air quality, water resources, ecological, or safety impacts to any environmental justice population would be anticipated.	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Environmental justice impacts would be the same as the Proposed Action.	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Environmental justice impacts would be the same as the Proposed Action.	The Tribal PFR Alternative assumes a new, but unidentified site between 3,000 and 1,200 acres on tribal lands. Environmental Justice issues would be analyzed in a subsequent NEPA action. Environmental justice impacts would be the same as the Proposed Action.	Major economic and social impacts including the loss of over 3,000 total jobs, many of which are currently held by Navajo and Hopi workers. The loss of revenues from NGS and the Kayenta Mine to the Navajo Nation and Hopi Tribe would reduce services and employment on the two reservations that would represent a major, long-term impact for the two tribes. Employment losses would have corresponding social effects and potentially result in relocation for affected Navajo and Hopi families or wage earners. These economic and social impacts would be considered major, and they would accrue disproportionately to the Navajo Nation and Hopi Tribe, which are environmental justice populations identified for this EIS.

Table 2-21 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.20 Indian Trust Assets	Minor to negligible impacts would be anticipated to Navajo Nation and Hopi Tribe Indian trust assets. The impacts on land, water, and mineral trust assets would be offset by the negotiated compensations and protection measures provided by lease and ROW agreements, environmental regulations, plans, and programs (e.g., Coal Combustion Residuals Rule, Groundwater Protection Plan), No impacts to land trust assets of the Kaibab Band of Paiute Indians or Moapa Band of Paiute Indians related to the transmission systems and communication sites. The WTS and STS would continue operations as described under the Air Quality Proposed Action. No impact on water rights trust assets for the CAP-affected tribes. Higher energy costs for pumping CAP water and associated effects of higher costs on deposits to the Development Fund could affect economics of CAP water utilization for some CAP-	The Natural Gas PFR Alternative assumes no new site disturbance compared to the Proposed Action. Project impacts on Indian trust assets for the Navajo Nation, Hopi Tribe, Kaibab Band of Paiute Indians, and Moapa Band of Paiute Indians would be the same as the Proposed Action. No impact on water rights Indian trust assets for the CAP-affected tribes (same as the Proposed Action). Pumping energy costs could be higher or lower than those under the Proposed Action, depending on the future price of natural gas. This potentially could affect deposits to the Development Fund and the economics of CAP water utilization for some CAP-affected tribes.	The Renewable PFR Alternative assumes no new site disturbance compared to the Proposed Action. Project impacts on Indian trust assets for the Navajo Nation, Hopi Tribe, Kaibab Band of Paiute Indians, and Moapa Band of Paiute Indians would be the same as the Proposed Action. No impact on water rights Indian trust assets for the CAP-affected tribes (same as the Proposed Action). Pumping energy costs would be higher than those under the Proposed Action, depending on the future price of natural gas. This potentially could affect deposits to the Development Fund and the economics of CAP water utilization for some CAP-affected tribes.	The Tribal PFR Alternative assumes a new, but unidentified site(s) between 3,000 and 1,200 acres on tribal lands. The affected tribe would receive financial compensation and could negotiate for other measures to address impacts on Indian trust assets. Site-specific impacts on Indian trust assets would be analyzed in a subsequent NEPA action. Project impacts of NGS, the proposed KMC, transmission systems, and communications sites on Indian trust assets for the Navajo Nation, Hopi Tribe, Kaibab Band of Paiute Indians, and Moapa Band of Paiute Indians would be the same as the Proposed Action. No impact on water rights Indian trust assets for the CAP-affected tribes (same as the Proposed Action). Pumping energy costs would be higher than those under the Proposed Action, potentially affecting deposits to the Development Fund and the economics of CAP water utilization for some CAP-affected tribes.	No negative impacts to Indian trust assets of the Navajo Nation or Hopi Tribe would be anticipated. However, payments from 2020 to 2044 from NGS (totaling $793 million to $1.07 billion to the Navajo Nation) and from the proposed KMC (combined total to the Navajo Nation and Hopi Tribe from $787 million to $1.16 billion) for the use of water, land, and mineral Indian trust assets would be foregone compared to the Proposed Action. Impacts to the WTS and STS are the same as described for the Air Quality No Action Alternative. No impacts from continued operations and maintenance of the WTS, STS, and communications sites to Indian trust land assets of the Kaibab Band of Paiute Indians or Moapa Band of Paiute Indians. No impact on water rights Indian trust assets for the CAP-affected tribes (same as the Proposed Action). Pumping energy costs for CAP

Table 2-21 Navajo Generating Station – Kayenta Mine Complex Project Impact Summary

Resource\ Alternative	Proposed Action	Natural Gas PFR	Renewable PFR	Tribal PFR	No Action
3.20 Indian Trust Assets (continued)	affected tribes.				water under No Action could result in energy costs of between 23 percent lower and 21 percent higher than under the Proposed Action, depending on the future price of natural gas. Deposits into the Development Fund would cease. The effects could affect the economics of CAP water utilization for some CAP-affected tribes.

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Chapter 3.0

Affected Environment and Environmental Consequences

Acronyms and Abbreviations

1969 Lease	Navajo Project Indenture of Lease
BART	Best Available Retrofit Technology
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BM&LP Railroad	Black Mesa & Lake Powell Railroad
BO	Biological Opinion
CAP	Central Arizona Project
CCR	Coal Combustion Residual
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CO_2	carbon dioxide
COPC	Chemical of Potential Concern
Co-tenants	Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
Development Fund	Lower Colorado River Basin Development Fund
EIS	Environmental Impact Statement
EPRI	Electric Power Research Institute
ERA	Ecological Risk Assessment
ESA	Endangered Species Act of 1973
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
km	kilometer
KMC	Kayenta Mine Complex
kV	kilovolt
kW	kilowatt
LTEMP	Long-term Experimental and Management Plan
MW	megawatt
N-Aquifer	Navajo Aquifer
NEPA	National Environmental Policy Act of 1969, as amended
NGS	Navajo Generating Station
NGS Participants	U.S. (Reclamation), Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
NHPA	National Historic Preservation Act
NNEPA	Navajo Nation Environmental Protection Agency
NO_2	nitrogen dioxide
NO_X	nitrogen oxide
OSMRE	Office of Surface Mining Reclamation and Enforcement
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 microns or less

PFR	Partial Federal Replacement
PWCC	Peabody Western Coal Company
Reclamation	U.S. Bureau of Reclamation
ROW	Right-of-way
SO_2	sulfur dioxide
SRP	Salt River Project Agricultural Improvement and Power District
STS	Southern Transmission System
U.S.	United States
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
WTS	Western Transmission System

Contents

3.0 Affected Environment and Environmental Consequences ... 3.0-1

3.0.1 Overview of the Scope of Analysis ... 3.0-1

3.0.2 Organization and Methodology for the Affected Environment and Environmental Consequences Chapter ... 3.0-2

3.0.2.1 Regulatory Framework ... 3.0-2

3.0.2.2 Study Areas ... 3.0-2

3.0.2.3 Affected Environment ... 3.0-3

3.0.2.4 Environmental Consequences ... 3.0-5

3.0.2.4.1 Issues ... 3.0-5

3.0.2.4.2 Assumptions and Impact Methodology ... 3.0-5

3.0.2.4.3 Proposed Action ... 3.0-5

3.0.3 Ecological and Human Health Risk Assessment Approach and Study Area Delineation ... 3.0-21

3.0.3.1 Risk Assessment Study Areas ... 3.0-23

3.0.3.1.1 NGS Near-field ... 3.0-23

3.0.3.1.2 San Juan River ... 3.0-25

3.0.3.1.3 Gap Regions ... 3.0-25

3.0.3.1.4 Proposed KMC ... 3.0-28

3.0.3.2 Ecological Risk Assessments ... 3.0-28

3.0.3.2.1 ERA Process and Applicability to the EIS Process ... 3.0-31

3.0.3.3 Human Health Risk Assessments ... 3.0-35

3.0.3.3.1 HHRA Process and Applicability to the EIS Process ... 3.0-36

3.0.3.4 References ... 3.0-37

List of Appendices

Appendix 3RA - Summary of Risk Assessments Conducted in Support of the NGS-KMC EIS

List of Tables

Table 3.0-1 Surface Disturbance (Acres) Summary for Past and Present Actions, Proposed Action, and Reasonably Foreseeable Future Actions for the NGS and Proposed KMC 3.0-4

Table 3.0-2 Land Area to be Reclaimed 3.0-5

Table 3.0-3 EIS Impact Magnitude Correlation to Biological Assessment Effect Determinations 3.0-7

Table 3.0-4 Operational Factors Scaled from the Proposed Action to Estimate Partial Federal Replacement Alternative Impacts 3.0-18

Table 3.0-5 Typical NGS Power Generation for the Proposed Action and PFR Alternatives 3.0-19

Table 3.0-6 Typical NGS Annual Water Use for the Proposed Action and PFR Alternatives 3.0-19

Table 3.0-7 Typical Proposed KMC Annual Coal Production for the Proposed Action and PFR Alternatives 3.0-20

Table 3.0-8 Typical Proposed KMC Surface Disturbance Estimates, for the Proposed Action and PFR Alternatives 3.0-20

List of Figures

Figure 3.0-1 Foreseeable Actions Regional Overview 3.0-10

Figure 3.0-2 Foreseeable Actions Eastern Extent Detail 3.0-11

Figure 3.0-3 Proposed Lake Powell Pipeline Project 3.0-15

Figure 3.0-4 Proposed Transmission Projects – Las Vegas Region 3.0-17

Figure 3.0-5 Navajo Generating Station Near-field Risk Assessment Study Area 3.0-24

Figure 3.0-6 San Juan River Watershed and Risk Assessment Study Area 3.0-26

Figure 3.0-7 Gap Regions and Risk Assessment Study Area 3.0-27

Figure 3.0-8 Proposed KMC Risk Assessment Study Area 3.0-29

3.0 Affected Environment and Environmental Consequences

The purpose of the Affected Environment and Environmental Consequences chapter is to document current environmental, social, and economic conditions (affected environment) and to disclose the potential direct, indirect, and cumulative environmental consequences from implementing the Proposed Action, the action alternatives, and the No Action Alternative (environmental consequences).

The subsections of this introductory Section 3.0 provide: 1) an overview of the scope of the analysis conducted in this chapter; 2) a description of the organization and methodology used to describe the affected environment and environmental consequences for each of the resources evaluated; and 3) an overview of the process by which specific study areas were defined for conducting risk assessments, as well as how the multidisciplinary ecological and human health risk assessments were conducted and used to assist in the evaluation of certain resources.

3.0.1 Overview of the Scope of Analysis

The Proposed Action includes a number of components (the proposed Kayenta Mine Complex [KMC], Navajo Generating Station [NGS], and transmission systems). These components are located in Arizona, southern Utah and eastern Nevada. As a result, a wide range of resources and habitats potentially can be affected. The National Environmental Policy Act defines the affected environment as the environment of the area(s) to be affected or created by the alternatives under consideration (40 Code of Federal Regulations [CFR] Part 1502.15). The environments of the study areas affected or created by the alternatives under consideration are many and varied, and are affected in different ways by the different components.

The effects of a proposed action include direct effects, indirect effects, and cumulative effects. Direct effects are those which are caused by the action and occur at the same time and place. Indirect effects are those which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable effects. Cumulative effects are the impacts on the environment which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions (40 CFR Parts 1508.7 and 1508.8).

The direct and indirect effects of the Proposed Action are the future changes that are the result of the action; however, to appropriately analyze the effects of the Proposed Action, the existing conditions provide an important context and starting point for changes to the environment that would be the result of the Proposed Action. The discussion of cumulative effects considers the effects of past and present actions, including historical and existing NGS, Kayenta Mine, and transmission system operations, as well as reasonably foreseeable future actions, where the project may have some incremental impact, even if it is negligible.

The majority of the analysis in the Environmental Impact Statement (EIS) is written from a Western scientific perspective. The subsection on Sociocultural Conditions and Trends in Section 3.18.3.1 (Socioeconomics) provides a description of the contemporary sociocultural setting in which the Proposed Action and action alternatives would occur. Many aspects of the contemporary sociocultural setting are rooted in traditional Native American culture and values. Native American traditional values are complex, and in many cases, not easily translated into English or effectively described by Western concepts or thinking. Section 3.18.3.3 provides a discussion of the natural and sociocultural resources, the environment, and traditional occupancy and use of land by the affected Native American community members from a traditional perspective. Insights into traditional perspectives draw upon tribal documents, summaries prepared by ethnographers with the participation or oversight of tribal historic preservation staff, and from ethnographic research documents and other published materials. Scoping comments and comments provided during listening sessions at the Kayenta Mine also helped inform the review of concerns based in Native American traditional values.

While the total project impact for each resource will be the sum of the direct, indirect, and cumulative impacts from all project components, the scope of the analysis will focus on effects by resource and by project component, because each of these will have different effects. The total project effects are presented in the Impact Summary Table in Chapter 2.0.

3.0.2 Organization and Methodology for the Affected Environment and Environmental Consequences Chapter

The Affected Environment and Environmental Consequences chapter is organized by resource topic (e.g., air quality and climate). The discussion for each topic in subsequent sections of Chapter 3.0 (e.g., Sections 3.1, 3.2, 3.3, etc.) is organized as follows.

3.0.2.1 Regulatory Framework

This section identifies for each resource the federal, tribal, and state regulatory programs that set numeric and qualitative standards for minimizing and controlling impacts. Compliance with these standards was considered in defining study areas and context for the impact assessments.

3.0.2.2 Study Areas

Potential effects vary by resource. The scope of analysis for each resource is defined by the potential areas affected (i.e., study area), the project components that may affect that study area, and the types of effects that could occur. The Proposed Action and alternatives study areas for direct impacts to surface resources (e.g., soils, vegetation) are primarily defined by existing and proposed project surface disturbance. Because both NGS and the proposed KMC are existing industrial facilities, the historical surface disturbance through 2019 is differentiated from future surface disturbance planned to occur from 2020 to 2044. These study areas are defined for each resource in the form of narrative and/or maps.

The Proposed Action and alternatives study areas for indirect impacts (e.g., deposition of trace metals from NGS stack and secondary emissions (e.g., fugitive dust from coal handling or ash disposal), mine-generated fugitive dust and consequent bioconcentration through terrestrial and aquatic food chains) are defined by the modeled NGS and proposed KMC air quality impacts over a near-field scale (out to 50 km) and a regional scale (out to 300 km) for NGS only. The basis for the risk assessment study areas is further discussed in Section 3.0.3.

The Proposed Action and alternatives study area for direct and indirect impacts of mine and community groundwater pumping on Black Mesa and surrounding area is the Navajo Aquifer (N-Aquifer), which is illustrated in Section 3.7, Water Resources, **Figure 3.7-2**.

Cumulative impact study areas are resource-specific and are defined to address the area of influence of past and present actions, the Proposed Action and other alternatives, and foreseeable future actions that overlap the range or occurrence of different resources.

Table 3.0-1 provides a summary of the surface disturbance associated with past and present actions, the Proposed Action, and reasonably foreseeable actions described later in this section. **Table 3.0-2** provides an estimate of the project surface area that will require topsoiling and reseeding at the end of 2019 in the event that the No Action Alternative is selected, and in 2044 at the end of the operating period evaluated in this EIS. For purposes of analysis, the following assumptions were made:

- 100 acres of surface facilities and buildings would remain at NGS as specified by the Lease Amendment No. 1 (or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1). The maximum footprint was assumed (3-Unit Operation, CCR landfill expansion). All demolition and reclamation of NGS would be completed by 2046 per Lease Amendment No. 1 (or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1), although one unit could be removed earlier. The same footprint would require treatment, regardless of the demolition schedule;
- All surface facilities would be removed from Kayenta Mine, although no specific agreements are in place; and
- The Kayenta Mine ratio of the amount of mining surface area disturbed and "graded but not seeded reclamation" in 2044 would be similar to the estimates for 2019, due to the practice of regrading concurrently with surface mining operations. This estimate is based on a 8.1 million tons per year (tpy) mining rate, similar to historical operations. A 5.5 million tpy mining rate under a 2-Unit NGS Operation is assumed to result in the same surface area to be reclaimed as the 8.1 million tpy operation.

3.0.2.3 Affected Environment

"The environmental impact statement shall succinctly describe the environment of the area(s) to be affected or created by the alternatives under consideration. The descriptions shall be no longer than is necessary to understand the effects of the alternatives" (40 CFR Part 1502.15). To meet this requirement, affected environment information is presented in summary form in the main body of the EIS, with reference to appendices and reports that support the discussion.

The content of the affected environment sections provides background for the issues presented in the Environmental Consequences and Mitigation sections for each resource. As described previously, the affected environment for each resource describes the conditions of the environment as of the end of 2019, when the current NGS lease expires. This section describes the existing environment, including the impacts of past and present human activities to capture and disclose the impacts of historical operations of NGS and the proposed KMC on resource values. The description forms the basis for the effects analysis in the Environmental Consequences and Mitigation section. In some instances, conditions at the time of the EIS preparation have been extrapolated to the end of 2019 to provide a common basis for all resource topics. Where this has been done, it is noted and explained.

Table 3.0-1 Surface Disturbance (Acres) Summary for Past and Present Actions, Proposed Action, and Reasonably Foreseeable Future Actions

Project Component	Past/Present Actions	Proposed Action 3-Unit NGS	Proposed Action 2-Unit NGS	Other Reasonably Foreseeable Future Actions	Total (3-Unit NGS)	Total (2-Unit NGS)
NGS	**3,485**	—	—	—	**3,724**	**3,684**
Power Plant and Coal Combustion Residual (CCR) Landfill	1,785	239	199	—	—	—
CCR Landfill Road	30	—		—	—	—
Water Supply Facilities	50	—		—	—	—
Black Mesa & Lake Powell (BM&LP) Railroad	1,620	—		—	—	—
Proposed KMC	**26,187**[1]	—		—	**31,475**	**30,986**
Coal Resource Area		5,230[5]	4,741[5]	—	—	—
NN Road 41		58	58	—	—	—
Transmission Lines and Communication Sites	**23,114**	—	—	**4,201**[6]	**27,315**	**27,315**
Western and Southern STS Transmission Systems (WTS and STS)	17,212[2]	—	—	—	—	—
Roads	5,752[3]	—	—	—	—	—
Substations, Switchyards, and Communication Sites	150 [4]	—	—	—	—	—
Total	**52,786**	**5,527**	**4,998**	**4,201**	**62,514**	**61,985**

[1] Represents total historic surface disturbance within the proposed KMC from mining, surface support facilities, roads, ponds, and other minor surface disturbance through 2015 (Peabody Western Coal Company [PWCC] Annual Reclamation Report, May 2016) plus estimated new mining surface disturbance through 2019 (Lehn 2016).

[2] Transmission line Right-of-Way (ROW) – 200-330 feet wide. Source: **Appendix 1B**, Navajo Project Operation and Maintenance Plan, Appendix A, Land and Ownership by Facility

[3] Access Road ROW – 50 feet wide. Access roads may be located within the 200-330-foot transmission line ROW, but were calculated separately based on actual road lengths.

[4] Substations, Switchyards, and Communications Sites. Source: **Appendix 1B**, Navajo Project

[5] Coal resource areas include mine pits, pit access ways, and soil and overburden piles, and transmission lines for dragline electrical power.

[6] New Las Vegas area transmission line ROWs – 200 feet wide; new Lake Powell water pipeline and pump station transmission line ROWs – 200 feet wide.

Table 3.0-2 Land Acreage to be Reclaimed

	NGS[1]	Kayenta Mine[2]	Total
2019 – No Action	3,624	5,648	9,272
2044 – Proposed Action or Alternatives	3,624	6,499	10,123

[1] Maximum NGS/railroad footprint (3,724 acres) – 100 acres for remaining structures.

[2] Kayenta Mine: Initial Program Unreclaimed; Initial Program Backfilled and Graded but not Topsoiled or Seeded; Permanent Program Unreclaimed; Permanent Program Backfilled and Graded but not Topsoiled or Seeded. These estimates also include surface facilities that would require decommissioning.

3.0.2.4 Environmental Consequences

3.0.2.4.1 Issues

Environmental issues evaluated under Environmental Consequences in each resource section were developed from public scoping, agency input, and requirements to track impacts through different media as part of ecological and human health risk assessments. The topic headers within the sections outline the issues that are addressed.

3.0.2.4.2 Assumptions and Impact Methodology

For each resource, this section describes the assumptions and procedures used to estimate impacts and the sources for the methodology used. Coordination among agencies to review proposed methods, and independent peer reviews by outside parties are described. The resulting protocols and supporting technical reports are included as appendices to the EIS.

3.0.2.4.3 Proposed Action

Due to the uncertainty regarding the amount of power that NGS would be required to generate subsequent to the divestiture of existing Co-tenants Los Angeles Department of Water and Power and NV Energy by the end of 2019, the EIS evaluates a Proposed Action that would operate over a range between a 3-Unit Operation and a 2-Unit Operation, as described in the following bullets for the NGS and proposed KMC. The specific operational activities are summarized in Section 1.7.1 for NGS, and Section 1.7.2 for the Kayenta Mine.

- The Proposed Action at the NGS evaluates impacts over a range from a 3-Unit Operation (2,250 megawatts [MW]) operation at the upper bound to a 2-Unit Operation (1,500 MW) at the lower bound, along with the operational impacts of associated NGS facilities (i.e., water supply pumping plant and pipeline, ash disposal site, BM&LP Railroad, and other ancillary plant facilities). Other possible operational scenarios and resulting impacts would lie between these upper and lower bounds.
- The Proposed Action at the proposed KMC evaluates the impacts of mining 8.1 million tpy to support an NGS 3-Unit Operation and the impacts of mining 5.5 million tpy to support an NGS 2-Unit Operation. Other possible operations and resulting impacts would lie between these upper and lower bounds. The geographic area of the Proposed Action encompasses coal resource areas planned for mining between 2020 and 2044, and the Navajo Route 41 realignment (**Figure 2-1**).

The Proposed Action for each of the three major project components (NGS and associated facilities, proposed KMC, and the transmission systems and communication sites) are evaluated separately because the operations of each component are different, resulting in different environmental impacts. In addition, while the actions authorizing these components are connected for EIS analysis, they are separated geographically, and most efficiently described separately. However, where the potential impacts of operations of the components would overlap (e.g., air emissions and deposition impacts from

NGS and the proposed KMC on human health and ecological communities), the technical analyses capture and the EIS discloses the combined effects and impacts on the environment.

The transmission systems (Western Transmission System [WTS] and Southern Transmission System [STS]) and communications sites are an established part of the western U.S. transmission grid and support reliability and delivery of power throughout the region, well beyond the power generated by the NGS. The focus of this EIS analysis for the Proposed Action and action alternatives is on continued operation and maintenance of the existing transmission lines, which require infrequent vehicle and equipment travel on existing access roads to the transmission system infrastructure and powerline ROWs corridor. In the event it is determined that some or all of the transmission systems and communication site ROWs are not renewed, a lengthy study and permitting process would need to occur before any decommissioning is initiated due to the essential and integral nature of these facilities with the western electric grid. See Section 2.3.3.3 for a description for analysis of the No Action Alternative.

For each resource, the Proposed Action is discussed by project component and then by impact issue or topical area. Impacts (which may be either adverse or beneficial) are expressed numerically or in narrative form, with a discussion of impact importance or compliance with certain regulatory thresholds. In some instances, the intensity and duration of impacts may be reduced through implementation of mitigation measures. Mitigation measures are described in terms of practicality (including cost if available) and effectiveness. Impacts remaining after mitigation are then estimated and compared across alternatives. Calculations used to estimate impacts are included in appendices that are referenced in the individual resource sections, where applicable. An impact magnitude conclusion and rationale for the conclusion is provided for each major impact topic in accordance with the following definitions:

- **None**. No impacts to the resource.
- **Negligible:** The impact to the resource would be at or below the levels of detection. It would be slight or not perceptible.
- **Minor:** The impact would be detectable but would not be outside the natural or typical range of variability. The impact could be of higher intensity, but short-term or infrequent or could occur more frequently or for a longer period of time but be of lower intensity. Mitigation, if implemented, would be easily applied and successful with a high degree of certainty.
- **Moderate:** The effects would be readily apparent and would result in measurable impacts to the resource. These impacts would affect the availability or natural recovery of those environmental elements over the long term. The impact could be substantial but of a short duration with no permanent impact to the resource. It is anticipated that mitigation, if implemented, would be successful with a high degree of certainty, based on prior examples with similar effects, and documented mitigation outcomes.
- **Major:** The effects would result in substantial impacts to the resource that would be readily apparent, consequential, and outside the natural or typical range of variability. Mitigation, if implemented, would be uncertain in its success, or ineffective with consequent long-term and permanent changes in the availability or natural recovery of the resource.

A summary is provided after the treatment of the discrete project components to provide an overall understanding of the project impacts to a particular resource, and to provide a basis for understanding how the entire project impact contributes to the cumulative impacts.

Preliminary determinations for effects to threatened and endangered species are contained in the Reclamation Biological Assessment, published concurrently with this Draft EIS. The determinations follow the terminology contained in the Endangered Species Act (ESA), and the implementation guidance (USFWS and National Marine Fisheries Service 1998). **Table 3.0-3** provides a general correlation of the EIS impact magnitude criteria to ESA effect determinations used in the Biological Assessment.

Table 3.0-3 EIS Impact Magnitude Correlation to Biological Assessment Effect Determinations

EIS Impact Magnitude	Biological Assessment Determinations	Biological Assessment Determination Definitions (USFWS and National Marine Fisheries Service 1998)
None	No Effect	The appropriate conclusion when the action agency determines its proposed action will not affect listed species or habitat.
Negligible	May affect – is not likely to adversely affect	*May affect* – the appropriate conclusion when a proposed action may pose any effects on listed species or designated critical habitats. *Is not likely to adversely affect* – the appropriate conclusion when effects on listed species are expected to be discountable, insignificant, or completely beneficial. Beneficial effects are contemporaneous positive effects without any adverse effects to the species. Insignificant effects relate to the size of the impact and should never reach a scale where a take occurs. Discountable effects are those extremely unlikely to occur. Based on best judgement, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur.
Minor, Moderate, Major[1]	May affect – is likely to adversely affect	*May affect* – the appropriate conclusion when a proposed action may pose any effects on listed species or designated critical habitats. *Is likely to adversely affect* – the appropriate finding in a biological assessment (or conclusion during informal consultation) if any adverse effect to listed species may occur as a direct or indirect result of the proposed action or its interrelated or interdependent actions, and the effect is not: discountable, insignificant or beneficial. In the event that the overall effect of the proposed action is beneficial to the listed species, but is also likely to cause some adverse effects, then the Proposed Action "is likely to adversely affect" the listed species.

[1] No major impacts were identified for listed species in the EIS.

3.0.2.4.4 Cumulative Impacts

Cumulative impacts are defined as "the impact on the environment which results from the incremental impact of the action when added to other past and present actions and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR Part 1508.7).

The following factors were considered in developing the cumulative impact assessment for each resource:

- **Cumulative Impacts Issues.** Resource issues that were evaluated for direct and indirect impacts also are evaluated to determine impacts that may occur when the incremental effects of the Proposed Action or other action alternatives are added to other past and present actions or reasonably foreseeable actions.
- **Geographic Scope of the Cumulative Impacts Analysis.** The geographic areas for cumulative analysis are determined for each resource issue by defining the geographic boundaries of a study area that is predicted to encompass the impacts of the Proposed Action or action alternative, as well as the relevant past and present actions and reasonably foreseeable future actions. A rationale is provided for each cumulative impacts study area.
- **Time Frame for the Cumulative Impacts Analysis.** The cumulative impact analysis time frames vary by resource and resource issue, and are dictated by the past and present, and

foreseeable actions that have been included in the analysis. For example, the Kayenta Mine groundwater analysis model includes a defined starting point for past actions, incorporates the pumping effects of the Proposed Action, and establishes a future impact endpoint that accounts for the cumulative effects of all actions after project groundwater pumping stops in 2057. Time frames for this EIS are defined as follows:

- Short-term: 2 years or shorter in duration
- Long-term: More than 2 years in duration

As the Proposed Action and Partial Federal Replacement (PFR) alternatives are planned to occur over a 25-year time frame, the majority of impacts would be long-term. When the time frame for an impact is not stated, it is assumed to be a long-term impact.

3.0.2.4.4.1 Past and Present Actions

The past and present actions that contribute to historical conditions (through 2019) are described in Chapter 1.0. The primary time frame for most past and present actions for NGS extends from the construction of the generating station in the mid-1970s through 2019; the time frame for the area encompassed within the mine lease area is the inception of mining on Black Mesa in the late 1960s through 2019.

- **NGS**: all facilities and operations within the plant site boundary (railroad loadout, coal storage, generation units, waste water ponds, landfills) through 2019; water supply pumping station, pipeline, 230-kilovolt (kV) transmission line and access road through 2019; CCR landfill (inactive and active areas through 2019), and access road. BM&LP Railroad, including the loadout silos at the terminus of the Kayenta Mine conveyor; railroad track from the loop at the loadout silos to the storage yard at NGS; track sidings.
- **Proposed KMC**: Former Black Mesa Mine reclaimed area, former Black Mesa Mine surface facilities; Kayenta Mine surface facilities, Kayenta Mine reclaimed and active mining areas through 2019; transportation infrastructure (haul roads, overland conveyor, power lines); water supply wells; water management infrastructure (temporary and permanent ponds); Navajo Route 41 (historical alignment through 2019).
- **Transmission System and Communication Sites**: The WTS and STS transmission line, switchyard, and substation ROWs; primary and secondary roads providing access to the transmission line ROWs. Nineteen communication sites (ROW or lease area), and associated access roads.

3.0.2.4.4.2 Reasonably Foreseeable Future Actions

The reasonably foreseeable future actions are described here because the activities associated with these actions would intersect or interact with the NGS and Kayenta Mine operations from 2020 through decommissioning, resulting in cumulative impacts. Identification of the reasonably foreseeable future actions is necessary to establish resource study areas that encompass the past and present actions, Proposed Action and action alternatives, and the reasonably foreseeable future actions.

Reasonably foreseeable future actions are defined as actions that are not speculative – they have been approved, are included in short- to medium-term planning and budget documents prepared by government agencies or other entities, or are likely to occur given trends (U.S. Environmental Protection Agency [USEPA] 1999). Potential future actions were identified through public and agency scoping, input from cooperating agencies, and available information on known projects or actions under consideration. Actions that meet all of the following criteria were considered reasonably foreseeable and are included in the cumulative impacts analysis for each resource:

- The impacts of the future action would occur within the same geographic area (impact area) and the same time frame as the impacts for the Proposed Action or other alternatives.
- The future action would affect the same environmental resources as the Proposed Action or other alternatives.
- There is a reasonable expectation the future action would occur; the future action is not speculative.
- There is sufficient information available to define the future action and assess cumulative impacts.

Based on the criteria above, the following foreseeable actions were identified as potential contributors to cumulative impacts in conjunction with the Proposed Action and action alternatives. **Figures 3.0-1** and **3.0-2** provide regional overviews of the foreseeable actions addressed in this EIS. A brief description of the action, its location, and its cumulative impact relationship to NGS and proposed KMC project components are provided below.

3.0.2.4.4.2.1 Regional Coal-fired and Other Generation Sources; other Regional Emissions Sources

The far-field photochemical air quality modeling (out to 300 km from NGS) incorporates future emissions changes resulting from expected modifications to coal-fired power plant operations needed to comply with the regional haze rule over the next 10 years as described in the 2025 USEPA projected emissions inventory indicated below. These changes include shutting down units and adding equipment to reduce nitrogen oxide. Major sources are shown in **Figure 3.1-1** and provided in **Table 3.1-3**.

For purposes of this EIS, emissions for the period of the Proposed Action are based on the following assumptions regarding reasonably foreseeable actions:

- The shutdown of two units at the San Juan Generating Station and installation of selective catalytic reduction on the remaining units during the action period of the Proposed Action (also see San Juan River Basin Water Uses and Projects below) (**Figure 3.0-2**).
- The shutdown of three units at the Four Corners Power Plant and installation of selective catalytic reduction on the remaining units during the action period of the Proposed Action(also see San Juan River Basin Water Uses and Projects below) (**Figure 3.0-2**).
- Emissions from other major sources, based on the database representing the 2025 emissions inventory developed by USEPA to develop the Particulate Matter Rule for the National Ambient Air Quality Standards (available at http://www.epa.gov/ttn/chief/emch).

For the NGS-KMC Project EIS air quality cumulative impact analysis, project emissions (including both NGS and the Kayenta Mine) were combined with the emissions from these regional sources to predict far-field concentrations of criteria air pollutants. Criteria pollutants and/or hazardous air pollutants were included in the cumulative analysis of visibility and regional haze; acid deposition effects on ecosystems; contributions to regional greenhouse gases affecting climate change; and trace metal deposition and uptake effects on special status fish and other species in the Colorado River watershed. Global mercury emissions and deposition rates were included as cumulative sources in the Ecological Risk Assessments (ERAs) and Human Health Risk Assessments (HHRAs) (Electric Power Research Institute [EPRI] 2016).

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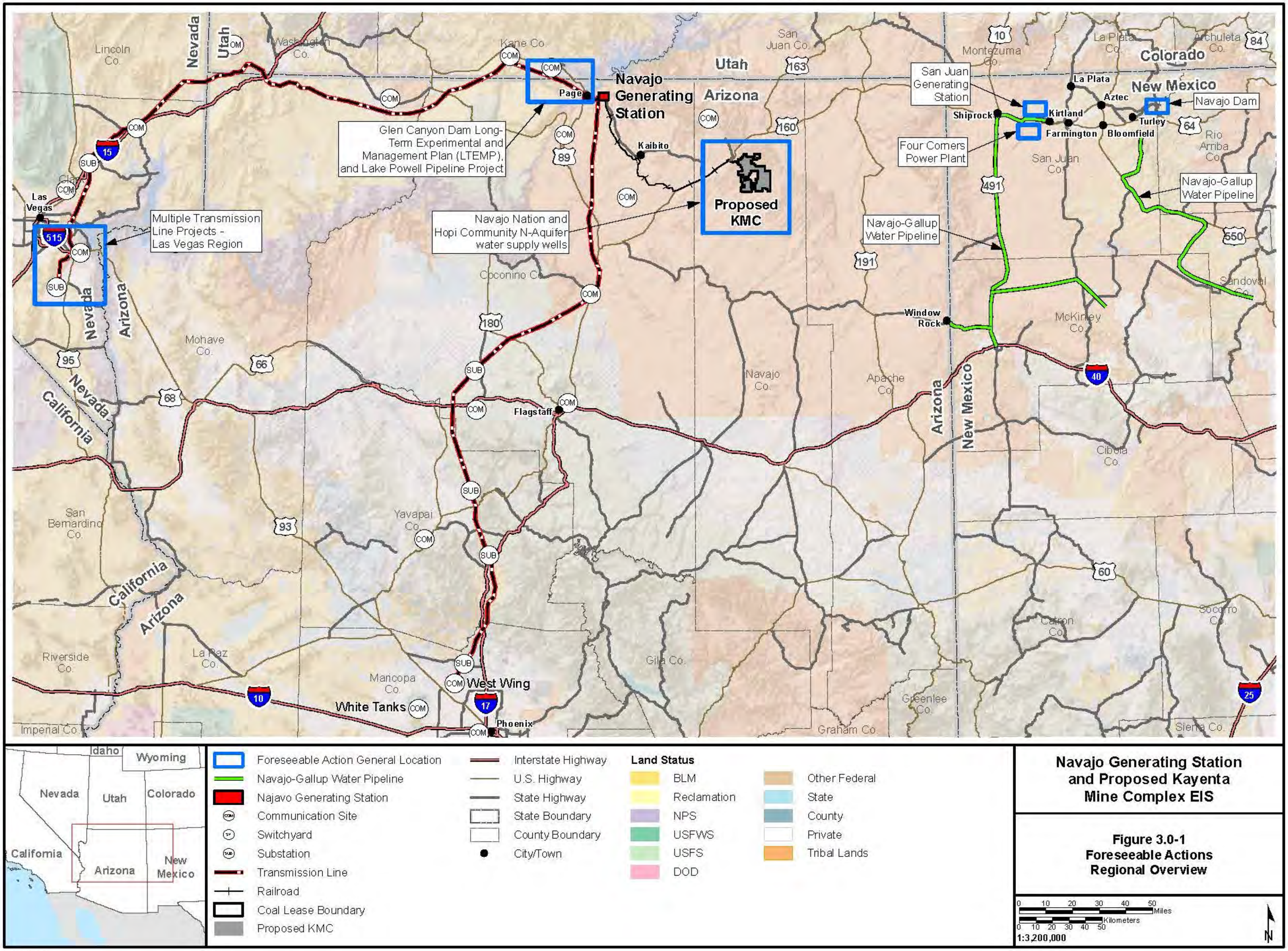

Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 3.0-1 Foreseeable Actions Regional Overview

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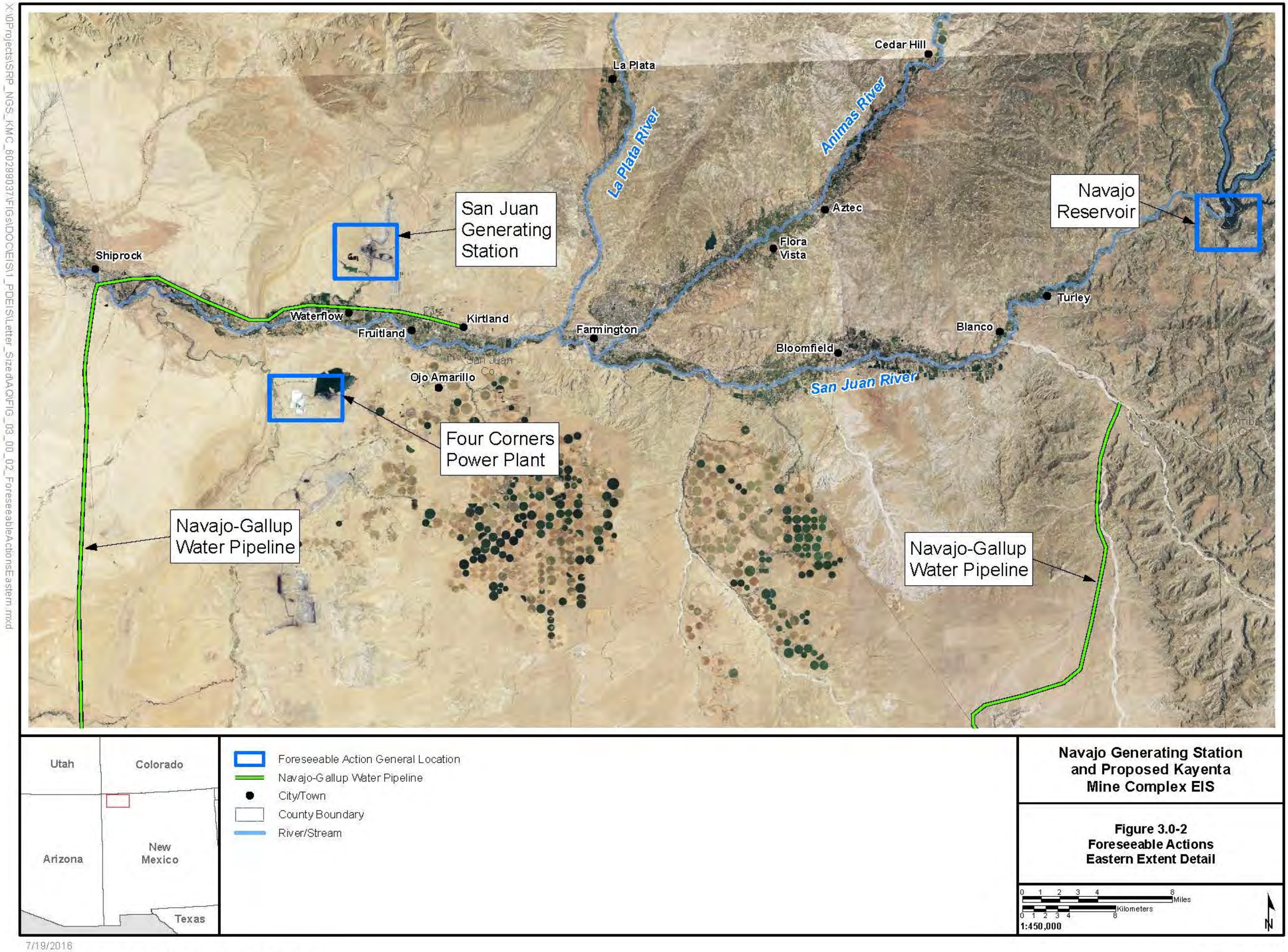
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Cedar Hill
La Plata
La Plata River
Animas River
Navajo Reservoir
San Juan Generating Station
Aztec
Flora Vista
Shiprock
Turley
Waterflow
Kirtland
Farmington
Blanco
Fruitland
Bloomfield
San Juan Co.
Ojo Amarillo
San Juan River
Four Corners Power Plant
Navajo-Gallup Water Pipeline
Navajo-Gallup Water Pipeline
Utah
Colorado
Arizona
New Mexico
Texas
Foreseeable Action General Location
Navajo-Gallup Water Pipeline
City/Town
County Boundary
River/Stream
Navajo Generating Station and Proposed Kayenta Mine Complex EIS
Figure 3.0-2
Foreseeable Actions
Eastern Extent Detail
0 1 2 3 4 8 Miles
0 1 2 3 4 8 Kilometers
1:450,000
N
7/19/2016

3.0.2.4.4.2.2 San Juan River Basin Water Uses and Projects

The San Juan River Ecological Risk Assessment (EPRI 2016) suggested potential impact to water quality and aquatic resources in the San Juan River Basin resulting from future NGS emissions. The upper San Juan River watershed encompasses a large area of southwestern Colorado. The river flows from Colorado into northwestern New Mexico and then across southern Utah to its confluence with Lake Powell. The primary San Juan River surface water storage is Navajo Reservoir east of Farmington, New Mexico, which is used as a regulator for a variety of diversions and releases for downstream users and instream resources, such as listed native fish species. A variety of municipal, agricultural, and industrial diversions are located above and below Navajo Reservoir. These include the Navajo Indian Irrigation Project; several irrigation company diversions; municipal diversions for Farmington, Aztec, Bloomfield, and Shiprock; and cooling water diversions for the San Juan and Four Corners power plants.

The following are foreseeable projects that would modify existing diversions or require new diversions from the river (**Figure 3.0-2**). These projects have received prior federal approvals, but project implementation would continue after 2019, coinciding with the Proposed Action analysis period for the NGS-KMC Project EIS.

Navajo-Gallup Water Pipeline. This project was approved in 2009 and is under construction. The purpose of this project is to provide new sources of water to a variety of Navajo Nation communities including Gallup, New Mexico. The project was analyzed in an EIS (U.S. Bureau of Reclamation [Reclamation] 2009), and a Biological Opinion (U.S. Fish and Wildlife Service 2009) was prepared that addressed project effects on the listed fish habitat in the river. The project would divert approximately 38,000 acre-feet from the San Juan River. However, this future depletion is almost entirely offset by Navajo Nation unused water assigned to the Navajo Indian Irrigation Project. San Juan River flows would be protected and maintained under a Depletion Guarantee, which sets an overall depletion threshold for the upper San Juan River Basin (U.S. Fish and Wildlife Service 2009). The Navajo Reservoir would continue to be operated to maintain the recommended river flow pattern specified in the San Juan River Basin Recovery Implementation Program.

Hogback-Cudei and Fruitland Canal Rehabilitation Projects. These irrigation projects were constructed for the benefit of the Navajo Nation between Farmington and Shiprock, New Mexico, in the early 1900s. The canals for these projects are proposed to be rehabilitated to reduce seepage losses, and improve water delivery efficiency to the irrigated lands. The environmental evaluation for these projects is being conducted by the Bureau of Indian Affairs.

San Juan Generating Station. In a Best Available Retrofit Technology agreement with USEPA, this Public Service of New Mexico 1,800-MW coal-fired power plant would shut down two units and install selective catalytic reduction units on the remaining two stacks. The shutdown for two units is scheduled for the end of 2017. Current diversions from the San Juan River are approximately 16,200 acre-feet per year (U.S. Fish and Wildlife Service 2009). The shutdown of two units would reduce water consumption by approximately 50 percent or 8,100 acre-feet (Public Service of New Mexico 2015).

Four Corners Power Plant. The Four Corners Power Plant diverts water from the San Juan River into Morgan Lake, a storage reservoir. As a result of a Best Available Retrofit Technology agreement with USEPA, the Four Corners Power Plant shut down three of five units in 2013, with an approximately 60 percent reduction in cooling water needs. On July 14, 2015, the Office of Surface Mining Reclamation and Enforcement issued a Record of Decision (Office of Surface Mining Reclamation and Enforcement 2015) that approved surface coal mining in existing and new Navajo Mine permit areas, a lease for the Four Corners Power Plant, and various ROWs for transmission lines and roads. The project Biological Opinion (U.S. Fish and Wildlife Service 2015) was attached to the Record of Decision. The Biological Opinion contains conservation measures designed to offset project impacts on threatened and endangered species, primarily the Colorado pikeminnow and the razorback sucker. The major areas addressed in the conservation measures are reduction of larval fish impingement and entrainment at the power plant diversion structure; non-native fish control measures; construction of fish passage structures; monitoring for effects of selenium and mercury in listed fish; fish habitat improvement within the San Juan River channel; support for the San Juan River Basin Recovery Implementation Program; water temperature effects study on Colorado pikeminnow; and implementation of surveys for southwestern willow flycatcher, western yellow-billed cuckoo, and endangered plant species.

For aquatic biology and special status species, there is a cumulative impacts overlap between NGS trace metal deposition impacts to the Colorado pikeminnow and the razorback sucker in the San Juan River watershed, and trace metal deposition from the power plant projects listed above in northwestern New Mexico. All projects discussed above divert from the San Juan River, which in turn affect the quantity and quality of riverine habitat downstream of the New Mexico/Utah border. The Endangered Species Act consultations and Biological Opinions for these projects provide background for ongoing Endangered Species Act consultations for the NGS-KMC Project.

Gold King Mine water release into the Animas River. On August 5, 2015, approximately 3 million gallons of acid mine drainage water were accidentally discharged from the Gold King Mine into the upper Animas River drainage in Colorado. The Animas River is a major tributary of the San Juan River. Water quality and sediment monitoring programs were immediately initiated by state and federal agencies at intervals along the Animas and San Juan River. The Utah Department of Water Quality conducted water quality sampling at five San Juan River locations from Montezuma Creek to Mexican Hat from August 2015 through October 2015 (UDWQ 2016a). Sample results were compared with human health and aquatic life screening levels over multiple sampling periods. Post-release plume metal concentrations in river sediments were both higher and lower than pre-release concentrations at some sampling sites; however, all 2015 sample concentrations were within the historical range of metals concentrations measured in the San Juan system. Additional UDWQ water sampling was conducted in February, March, April, and June 2016 (UDWQ 2016b). The results of this sampling were screened against recreational, drinking water, agricultural, and aquatic life criteria. With the exception of aluminum criteria for aquatic life and total dissolved solids for agriculture, no exceedances of criteria were identified. Monitoring of water quality and sediments will continue to determine the potential for long term trace metal effects on ecological and human health. In March 2016, the USEPA issued a conceptual monitoring plan (USEPA 2016) that addressed Animas and San Juan River water, sediment, macroinvertebrate, and fish sampling scheduled for 2016. The plan included San Juan River sites previously sampled by UDWQ in 2015. Monitoring of the sites included in the USEPA plan may continue after 2016.

3.0.2.4.4.2.3 Glen Canyon Dam Long-term Experimental and Management Plan

The U.S. Department of Interior, through the Reclamation and the National Park Service proposes to develop and implement a Long-term Experimental and Management Plan (LTEMP) for operations of Glen Canyon Dam (**Figure 3.0-1**). The LTEMP would provide a framework for adaptively managing Glen Canyon Dam operations over the next 20 years with the goal of creating certainty and predictability for power and water users while protecting environmental and cultural resources in Grand Canyon National Park and the Colorado River Ecosystem.

The LTEMP Draft EIS (Reclamation and National Park Service 2015) evaluates the effects of different reservoir release alternatives on resources including sediment resources, aquatic and terrestrial ecological resources, historic and cultural resources, resources of importance to Native American Tribes, recreational resources, and designated wilderness in the vicinity of Glen Canyon and the Grand Canyon; as well as socioeconomic resources, hydropower resources, and air quality.

For the aquatic biology and special status species cumulative impact analysis, estimated future instream habitat conditions (i.e., water volume, water chemistry and temperature) resulting from implementation of the LTEMP alternatives were considered in the context of trace metal deposition from the NGS stacks and consequential ecological risks (see Section 3.02, Ecological and Human Risks Assessment). The LTEMP incorporates a number of measures to increase the likelihood of humpback chub (*Gila cypha*) endangered fish recovery and reduction in non-native fish invasion.

The NGS-KMC Project has considered the LTEMP measures in the development of conservation measures included in this EIS and in the resulting Endangered Species Act Section 7 consultation with U.S. Fish and Wildlife Service. The NGS-KMC Project conservation measure program is designed to be consistent with the LTEMP goals and to contribute to overall listed fish recovery goals in the Colorado River system.

3.0.2.4.4.2.4 Lake Powell Pipeline Project

The Utah Board of Water Resources has proposed the construction and operation of a 158-mile water pipeline that would extend from an intake structure in Lake Powell to Sand Hollow Reservoir near Saint George, Utah. In addition to the pipeline, the project would construct transmission lines to provide power to pump stations and to receive power from hydropower generation. Total planned water withdrawal from Lake Powell would be approximately 90,000 acre-feet annually. The project likely would be constructed by 2025, and then would operate indefinitely. The water pipeline (maximum diameter 69 inches) would be constructed in a 120-foot-wide construction ROW and operated in a 100-foot-wide permanent ROW. The 230-kV transmission line would be constructed in a 150-foot-wide ROW.

For the NGS and proposed KMC natural and cultural resources and land surface cumulative analysis, two segments of the Lake Powell Pipeline Project would be located in the existing utility corridor (approximately 500 feet wide) occupied by the WTS in Coconino County, Arizona (**Figure 3.0-3**). From the vicinity of Glen Canyon Dam to Buckskin Mountain, a 230-kV transmission line would be constructed parallel to an existing 138-kV Garkane transmission line as well as the WTS transmission line over a distance of approximately 29 miles. The water pipeline would be located parallel to the WTS over a distance of approximately 33 miles, assuming construction across the Kaibab Band of Paiute Reservation.

For the NGS and proposed KMC water resource cumulative analysis, the magnitude of the proposed Lake Powell pipeline diversions on fisheries habitat in Lake Powell is considered relative to the NGS water withdrawals, lake levels, and associated fisheries habitat.

Primary land surface resource cumulative impact issues that apply to existing and new facilities within the existing utility corridor shared by the WTS and the Lake Powell pipeline and transmission line include soil resources (disturbance and stabilization); vegetation and special status species (removal and revegetation); wildlife and special status species (habitat losses, direct losses of non-mobile individuals, short term displacement from construction activities); land use (expansion of the utility corridor width, temporary reduction in grazing use); transportation (use of existing access roads by multiple utility operations, creation of new roads requiring maintenance); and cultural resources (disturbance of cultural resources, effects on traditional cultural properties).

3.0.2.4.4.2.5 Navajo Nation and Hopi Community N-Aquifer Water Supply Wells

Groundwater modeling for drawdown effects on the regional N-Aquifer, the primary groundwater source for Black Mesa, included assumptions about location and volume of water that would be withdrawn from community wells from 2020 to 2057. The region surrounding the proposed KMC where these communities are located is provided on **Figure 3.0-1**. A detailed discussion of the water demand assumptions is included in Section 3.7, Water Resources.

- <u>Future projections for existing communities</u>. Increases in future water demands were estimated from community population growth projections as well as changes in future per capita demand. The existing communities for which future water demand projections were made include Tuba City, Kayenta, Pinon, Moenkopi District, Shonto, and Polacca.

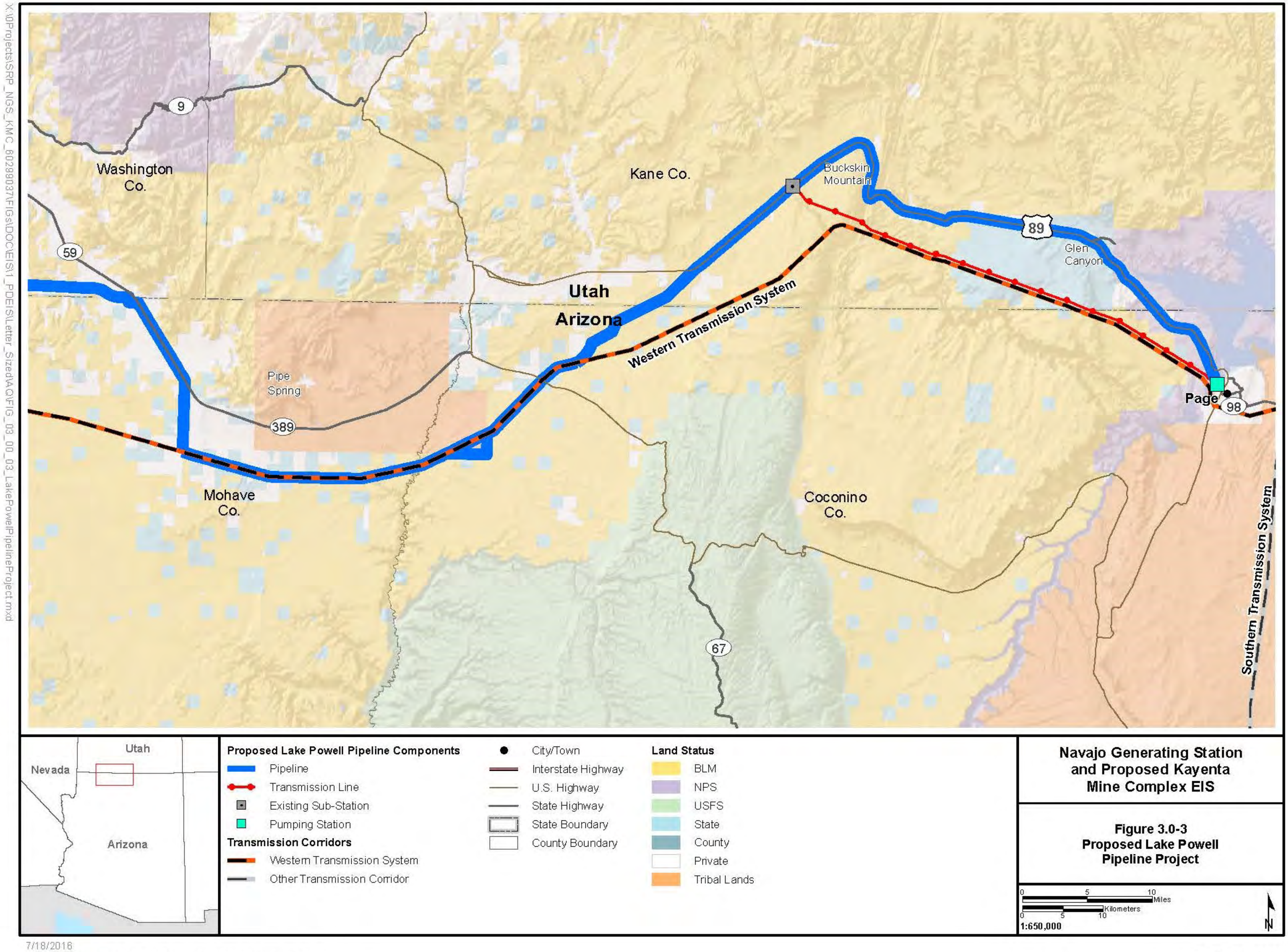

Figure 3.0-3
Proposed Lake Powell Pipeline Project

- Future projections for new communities. New Hopi communities have been proposed at several locations that would require new sources of groundwater supply. These communities include Tawa'ovi, Howell Mesa East and West, Spider Mound, and South Oraibi. The Navajo Nation's Many Mules water development project within the Kayenta Mine area would utilize an existing mine water supply well for domestic use. This water use conversion may occur prior to 2020, however the new extended use has been considered in the groundwater modeling.
- Replacement wells for existing wells. The Hopi Arsenic Mitigation Project to replace arsenic contaminated wells on the Hopi Reservation is planned for completion after 2020, and expected future use was estimated for groundwater modeling.

3.0.2.4.4.2.6 Multiple Transmission Line Projects – Las Vegas Region

Multiple high voltage (230 kV and higher) transmission line projects have recently been proposed for construction within an existing West-Wide utility corridor east and south of Las Vegas; collocated with the WTS. **Figure 3.0-4** illustrates the various projects that may be constructed by 2025 within this utility corridor. These projects are described in relation to the WTS.

- TransWest Express Transmission Project. The proposed TransWest Express Project is a 725-mile-long, 600-kV direct current transmission line that would extend from central Wyoming to a terminus in the Eldorado Valley south of Las Vegas (Bureau of Land Management [BLM] 2015). Average transmission line ROW width would be approximately 150 feet. The project would utilize existing access roads when located in an existing utility corridor, and new roads would be required where no utility projects currently exist. The BLM Record of Decision for this project is expected in 2016; construction of the project likely would occur over a 5-year period. The TransWest Express Project parallels the WTS over a distance of 102 miles.
- Great Basin Transmission/NV Energy Southern Nevada Intertie Project. The proposed 60-mile 500-kV alternating current transmission line would extend from the Harry Allen Power Plant northeast of Las Vegas to the Mead Substation south of Henderson, Nevada (BLM 2012). The Southern Nevada Intertie Project would parallel the WTS over a distance of 40 miles.
- Silver States Energy Associates Eastern Nevada Transmission Project (ENTP Silverhawk-Newport). The proposed 230-kV alternating current transmission line would extend from the Newport Substation on the southeast side of the Las Vegas metropolitan area north to the Gemmill Substation north of the Silverhawk Power Plant. The Eastern Nevada Project would parallel the WTS over a distance of 23 miles.

The types of expected cumulative land surface resource impacts to terrestrial resources would be similar to those described for the Lake Powell Pipeline project.

3.0.2.4.5 Partial Federal Replacement Alternatives

Three action alternatives to offset part of the federal share of NGS were developed as described in Section 2.3.2. For each PFR alternative (natural gas, renewable, and tribal), the NGS federal power generation share would be reduced (curtailed) by between 100 MW up to 250 MW; proportionally less coal would be mined at the Kayenta Mine. The operational assumptions for these alternatives are discussed in Section 2.3.2 and **Appendix 2A**.

Implementation of the PFR alternatives would proportionally reduce the annual quantity of coal burned at NGS and, consequently, the amount of emissions produced at NGS and annual volume of coal mined at the Kayenta Mine. These changes represent the primary operational differences from the Proposed Action, and can be used to estimate the impact of the action alternatives on resources and human activities at NGS (including the BM&LP Railroad), and the proposed KMC. Where possible, the impacts of the action alternatives were scaled from the impact estimates developed for the Proposed Action for the range represented by the NGS 3-Unit Operation and 2-Unit Operation. However, for air

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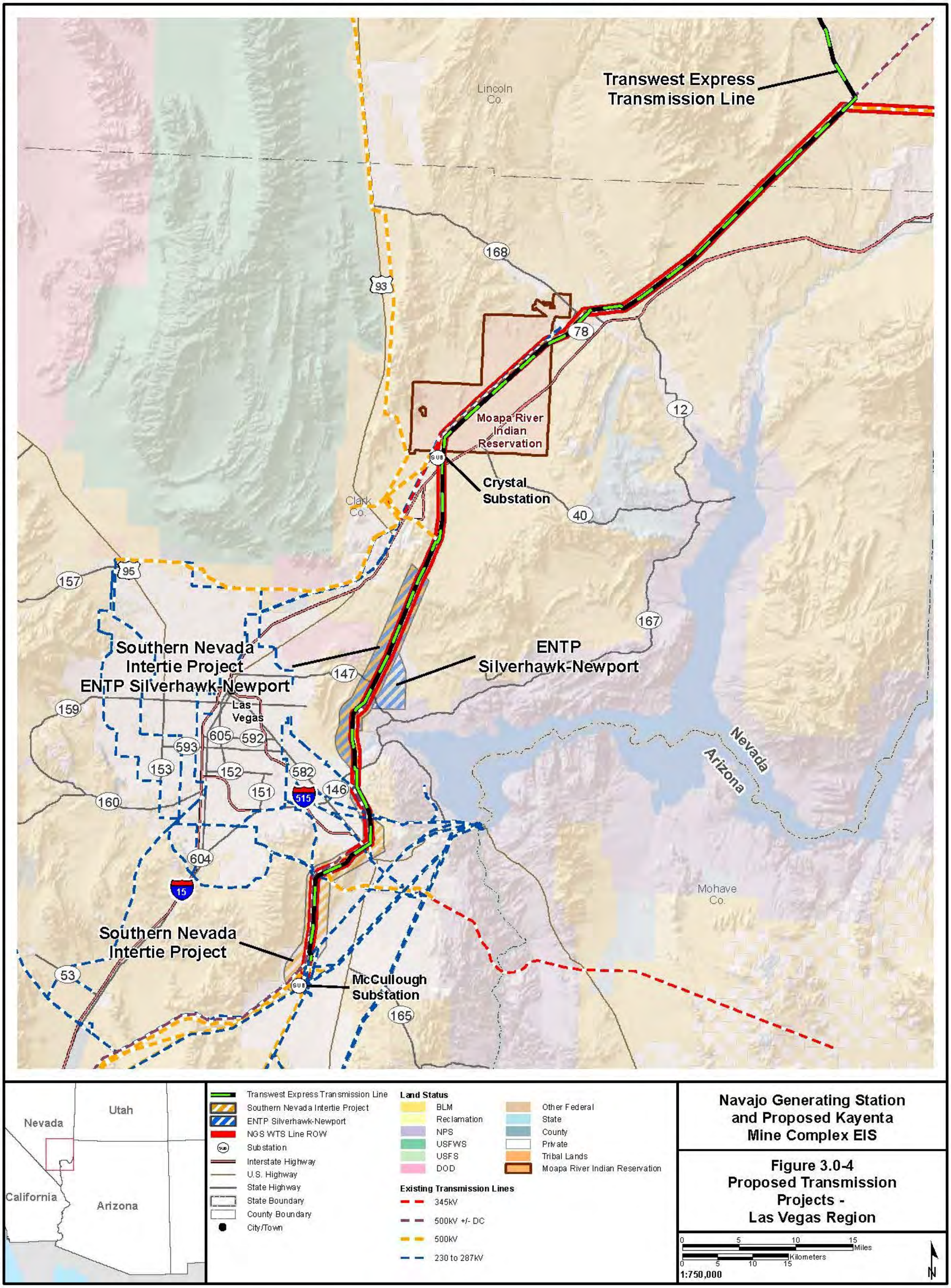

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quality near NGS the maximum impacts for criteria air pollutants (except SO_2 and most trace metals) are dominated by emissions from ground-level operational sources at NGS, which would remain the same regardless of whether the 3-Unit Operation or 2-Unit Operation would be implemented. In this case, air impacts were adjusted by the change in power production and by the relative change in impacts from stack emissions, with the emissions from ground-level operational sources remaining constant.

The values estimated by scaling were then used to estimate other indirect impacts. For example, changes in coal production affect the number of mine workers and the amount of new surface disturbance required to achieve a certain amount of production.

The operational factors that used a scaling approach to compare the impacts of the Proposed Action to those of the PFR alternatives are summarized in **Table 3.0-4**, along with resource applicability and rationale for the scaling approach for each factor.

Table 3.0-4 Operational Factors Scaled from the Proposed Action to Estimate Partial Federal Replacement Alternative Impacts

Operational Factors	Resource Applicability	Scaling Approach Assumptions
NGS Power Generation (**Table 3.0-2**)	Socioeconomics, Air Quality, Climate Change, ERA, HHRA, Soils, Water, Vegetation, Wildlife, Aquatic Biology	The changes in NGS output are based on the power generation assumptions for each PFR. These estimates represent a change in NGS output in response to specific assumptions for how the PFR alternative would operate.
NGS Water Use (**Table 3.0-4**)	Water Resources, Aquatic Biology	NGS water use from the Lake Powell source generally is proportional to the power generated. The scaling for water use was derived from NGS power generation.
Proposed KMC Coal Production (**Tables 3.0-5** and **3.0-6**)	Socioeconomics, Geology, Paleontology, Soils, Vegetation, Wildlife, Land Use, Water Resources, Cultural Resources, Environmental Justice, Indian Trust Assets	The changes in volume of coal mined are dependent on the volume of coal burned at NGS to generate electrical power. It is assumed that the same coal resource areas would be mined, but at a lower rate and on a modified schedule compared to the Proposed Action. Surface disturbance estimates are based upon this same scaling approach.
Proposed KMC Groundwater Use	Water Resource, Socioeconomics, Geology, Paleontology, Soils, Vegetation, Wildlife, Land Use, Cultural Resources, Environmental Justice, Indian Trust Assets	Groundwater pumping volumes were assumed to be constant, regardless of the volume of coal mined for the period 2020-2044 because water would be used primarily for dust control along existing roads. Therefore no proposed KMC groundwater use comparisons were made among alternatives.

Table 3.0-4 Operational Factors Scaled from the Proposed Action to Estimate Partial Federal Replacement Alternative Impacts

Operational Factors	Resource Applicability	Scaling Approach Assumptions
Proposed KMC Particulate Emissions – Index for trace metals deposition and air concentrations	ERA, HHRA, Land Use, Soils, Vegetation, Wildlife, Special Status Species	Particulate emissions and deposition cannot be scaled for the proposed KMC due to the number of variables and uncertainties involved; therefore, a qualitative assessment was made.

Tables 3.0-5 through **3.0-8** provide the impact variables that were scaled from the Proposed Action 3-Unit Operation and 2-Unit Operation to provide the proportional differences for each of the PFR alternatives.

Table 3.0-5 Typical NGS Power Generation for the Proposed Action and PFR Alternatives

Power Generation	Proposed Action[1]	Natural Gas PFR		Renewable PFR		Tribal PFR	
		100-MW	250-MW	100-MW	250-MW	100-MW	250-MW
NGS 3-Unit Operation							
MW	1,980	1,880	1,730	1,922	1,834	1,939	1,877
% Change from Proposed Action		-5%	-13%	-3%	-7%	-2%	-5%
NGS 2-Unit Operation							
MW	1,320	1,220	1,070	1,268	1,174	1,279	1,217
% Change from Proposed Action		-8%	-19%	-4%	-11%	-3%	-8%

[1] NGS typical output is operating at 88 percent capacity.

Table 3.0-6 Typical NGS Annual Water Use for the Proposed Action and PFR Alternatives

Typical Water Use	Proposed Action	Natural Gas PFR		Renewable PFR		Tribal PFR	
		100-MW	250-MW	100-MW	250-MW	100-MW	250-MW
NGS 3-Unit Operation							
acre-feet	29,000	27,840	25,230	28,130	27,260	28,420	27,550
% Change from Proposed Action		-4%	-13%	-3%	-6%	-2%	-5%
NGS 2-Unit Operation							
acre-feet	19,340	17,986	16,052	18,566	17,406	18,760	17,986
% Change from Proposed Action		-7%	-17%	-4%	-10%	-3%	-7%

Table 3.0-7 Typical Proposed KMC Annual Coal Production for the Proposed Action and PFR Alternatives

Coal Production	Proposed Action	Natural Gas PFR		Renewable PFR		Tribal PFR	
		100-MW	250-MW	100-MW	250-MW	100-MW	250-MW
NGS 3-Unit Operation							
million tpy	8.1	7.714	7.135	7.875	7.537	7.941	7.701
% Change from Proposed Action		-5%	-12%	-2%	-7%	-2%	-5%
NGS 2-Unit Operation							
million tpy	5.5	5.114	4.535	5.275	4.937	5.341	5.101
% Change from Proposed Action		-7%	-18%	-4%	-11%	-4%	-7%

Table 3.0-8 Typical Proposed KMC Surface Disturbance Estimates for the Proposed Action and PFR Alternatives

Surface Disturbance Estimates	Proposed Action	Natural Gas PFR		Renewable PFR		Tribal PFR	
		100-MW	250-MW	100-MW	250-MW	100-MW	250-MW
NGS 3-Unit Operation							
acres	5,230	4,968	4,602	5,072	4,863	5,124	4,968
% Change from Proposed Action		-5%	-12%	-3%	-7%	-2%	-5%
NGS 2-Unit Operation							
acres	4,741	4,409	3,888	4,551	4,267	4,599	4,409
% Change from Proposed Action		-7%	-18%	-4%	-10%	-3%	-7%

For the transmission systems (WTS and STS) and communications sites, the focus of this EIS analysis for the proposed action and PFR alternatives is on continued operation and maintenance of the existing transmission lines, which require infrequent vehicle and equipment travel on existing access roads to the transmission system infrastructure and powerline ROWs corridor. Additional disturbance of unknown acreage could occur under the Tribal PFR related to construction of a tie-line to connect one or more photovoltaic solar sites to the transmission system.

Cumulative impacts for the PFR alternatives would be considered in a similar fashion as previously described for the Proposed Action.

3.0.2.4.6 No Action

As described in Section 2.3.3, No Action means that none of the federal approvals required for continued operation at NGS or the proposed KMC would be granted and all currently active facilities would cease operations and be decommissioned and the land reclaimed. The No Action Alternative takes into account actions that would continue to occur in the absence of the Proposed Action or other action alternatives. An example is the continued pumping of community wells in the vicinity of the Kayenta Mine to support existing and expanding residential populations.

The NGS transmission system is an established part of the western U.S. transmission grid and supports reliability and delivery of power throughout the region, well beyond the power generated by the NGS. Therefore, under the No Action Alternative it is likely that that one, several, or all of the land owners/managers of the transmission line rights-of-way and communication site leases would renew some portion of the facilities to keep the power grid performing as expected.

In the event it is determined that some or all of the transmission systems and communication site ROWs are not renewed, a lengthy study and permitting process would need to occur before any decommissioning is initiated due to the essential and integral nature of these facilities with the western electric grid. As noted in Section 2.3.3.3, up to 4,826 acres within and alongside the transmission system corridors could be temporarily disturbed if the entirety of the transmission systems and communication sites were decommissioned and removed.

3.0.2.4.7 Comparison of Alternatives

An evaluation of the impacts of the Proposed Action, PFR alternatives, and No Action Alternative is provided in a tabular comparison of impacts at the conclusion of Chapter 2.0.

3.0.3 Ecological and Human Health Risk Assessment Approach and Study Area Delineation

Risk assessment is the estimation of the risk of impairment to human health and/or the environment (plants and animals) posed by chemicals present at naturally occurring levels in the environment or in association with environmental contamination, and is an important part of the environmental study process. The risk assessments conducted are very conservative in nature; i.e., protective of or “conserving” health and wellbeing. Due to the conservative assumptions made in each step of the risk assessment processes, it is likely they overestimate, rather than underestimate, potential risk. Thus, if it is determined that a risk may exist it does not mean that people, plants or animals currently are experiencing any adverse effects or harm but rather suggests that further analysis may be warranted to improve understanding of potential impacts before making an impact determination. Alternately, if the risk assessments conclude that there are no potential for risk or risk is negligible, then no further consideration or additional evaluation would need to occur.

The purpose of the ERA and the HHRA for NGS (and associated facilities) is to trace the movement of chemicals within ecosystems, and then to estimate concentrations of chemicals of potential concern (COPCs) through direct contact and through ecological and human food chains to determine if these chemicals could cause impairment to human health and/or ecological communities, including specific sensitive plant, wildlife, and fish species. The NGS risk assessments consider baseline or existing conditions as well as the impact of future NGS (project) emissions and emissions from other sources (regional and global). Similarly, the Proposed KMC risk assessments evaluate baseline conditions as well as the impact of potential future proposed KMC operations (coal production and reclamation activities to support NGS 3-Unit Operation and 2-Unit Operation), as they relate to ground-level emissions (fugitive dusts), and atmospheric emissions from other (cumulative) sources (regional and global).

Due to the time it takes for project emissions to be deposited and move through ecosystems for future atmospheric emissions, the ERAs and the NGS HHRA assessed the impact of NGS and cumulative emissions for the time period from year 2020 to 2074, 30 years after the planned shutdown of NGS in 2044. The additional 30-year time frame was selected based on the analysis and results of the EPRI study (EPRI 2016) that evaluated trace metal impacts on aquatic organism in the San Juan River watershed. The focus of the EPRI study was to determine the effect of projected changes in source emissions of arsenic, mercury, and selenium on terrestrial and surface water ecosystem concentrations of these chemicals in the San Juan River Basin. The additional 30-year time frame was selected to account for the San Juan River watershed response to future atmospheric deposition. While some atmospheric deposition falls directly onto surface water, most falls on to the larger terrestrial component of the watershed. Given the large storage capacity of soils, the movement of atmospheric inputs through the watershed system and ultimate release to surface water may take years to become evident. Therefore, the watershed response to atmospheric deposition is a function of fate (transformation) and transport processes that dictate the movement of deposited chemicals within the terrestrial, aquatic (surface water) and groundwater components, including movement through the food web.

The HHRA and ERA were used to characterize exposure and potential risk for project-related chemicals of concern under multiple exposure scenarios (baseline, future NGS and proposed KMC operations, and other cumulative sources) and multiple receptors. The risk assessments inform the development of the Affected Environment and Environmental Consequences sections and fulfill, in part, the information needed to fully address these EIS components. Therefore, these assessments inform the analysis of impacts of the Proposed Action and alternatives on soil, vegetation, terrestrial and aquatic resources, and human health. Because of the interdisciplinary inputs required for the risk assessments, an initial outline of the risk assessment approach is provided below, with reference to other locations in the EIS where these topics are discussed. A more detailed overview of the risk assessment process and sources of inputs to the process are presented in **Appendix 3RA**.

The major chemicals of concern addressed in this EIS are focused on substances contained in coal which are then released via power plant stack emissions or fugitive dust from coal combustion residual handling, storage, and disposal (i.e., wind-blown fugitive emissions from the NGS dry ash disposal landfill). Other coal-related sources (unrelated to the combustion of coal) include fugitive dust generated by mining activities and operation and maintenance activities related to coal handling at NGS. The emission impacts of diesel engine emissions (i.e., diesel particulate matter) generated from the proposed KMC and NGS equipment and vehicle use also were analyzed. Trace metal and other chemical concentrations were compiled for ambient air, soils, water, sediment, and fish tissue from recent investigations within the Colorado River drainage, as well as from new field sampling conducted in 2014 in the vicinity of NGS and the proposed KMC. Summaries of background trace metal concentrations for these media are provided in the Affected Environment sections of the Air Quality, Soils, Water Resources, Terrestrial Wildlife, and Aquatic Resources to provide perspective. More detailed summaries are provided in supporting appendices for these resource topics and in each of the risk assessment reports conducted for the project.

The risk assessments were conducted in accordance with the USEPA ERA Guidance (USEPA 2001, 1999, 1998, 1997) and HHRA Guidance (USEPA 2009, 2005, 1989). These guidance documents define the risk assessment framework and process for evaluating the potential for adverse effects. Although some methods and input parameters differ between HHRA and ERA guidance, the overall process components are the same. Key components or steps of the USEPA risk assessment process include:

- **Problem Formulation/Hazard Identification.** Problem formulation and hazard identification comprise the initial planning steps used to guide the risk assessment process. This includes characterizing the site setting, identifying potential chemical hazards and COPC for inclusion in the risk assessment process, and identifying how people and/or plants and animals can be exposed to these chemical hazards. This information is integrated into a conceptual depiction of potential exposed populations (receptors) and the various ways in which they may be exposed to site-related chemicals.
- **Analysis (Exposure/Effects Assessments).** The exposure assessment identifies potential exposure pathways, exposure assumptions and an evaluation of the constituent concentrations to which ecological and human receptors are exposed. The effects assessment describes the toxicity values used to estimate exposure for all exposure pathways and the potential adverse effects associated with the chemicals of potential ecological and human health concern to each receptor defined in the problem formulation/hazard identification.

- **Risk Characterization/Uncertainty Analysis.** Risk characterization integrates the problem formulation/hazard identification and exposure/effects assessment phases to develop quantitative estimates of risk. Risk estimates are developed for each receptor and chemical and represented by the hazard quotient for individual chemicals for ecological and human health evaluations. In addition, human health evaluations develop a hazard index for chemicals that do not cause cancer (non-carcinogens) and cancer risk estimates for chemicals with carcinogenic potential (carcinogens). The uncertainty analysis discusses general uncertainties inherent to all risk assessments, as well as site-specific uncertainties related to parameters such as exposure assumptions and/or toxicity information that underlie the risk estimates to provide site-specific context to the risk results.

3.0.3.1 Risk Assessment Study Areas

Five distinct study areas were identified and analyzed for the four ERAs and/or two HHRAs conducted for the project. Different types of air quality dispersion models were used to estimate the deposition rates of trace metals and other hazardous air pollutant compounds in stack emissions and in fugitive dust generated by mining activities within the appropriate modeling domain. The NGS and proposed KMC air dispersion models were coordinated such that combined impacts of both NGS and proposed KMC emissions and deposition were incorporated into the ERAs and HHRAs. The following is a summary of each study area and how it was defined.

3.0.3.1.1 NGS Near-field

The NGS Near-field ERA evaluated a suite of target chemical constituents (chemicals of potential ecological concern) including inorganic chemicals (metals, including arsenic, mercury and selenium) and organic chemicals (e.g., dioxins/furans and polycyclic aromatic hydrocarbons). Among those chemicals of potential ecological concern present in NGS stack emissions, selenium was identified as having the highest rate of deposition (propensity to fall out of the atmosphere) than any other chemicals of potential ecological concern (Ramboll Environ 2016a). Selenium was therefore chosen to represent all other chemicals of potential ecological concern for defining the near-field study area. A conservative soil deposition threshold, or soil concentration at or below which no adverse effects to human health or the environment is expected, was developed based on NGS stack/emission parameters and meteorological considerations using the AERMOD atmospheric dispersion modeling system (Ramboll Environ 2016a). A protective soil deposition rate of 52 micrograms of selenium per square meter of soil per year was estimated and used to determine the study area boundary. This rate is protective of ecological (and human health) receptors exposed to selenium deposited to soil, and receptors present in areas where the deposition rate is lower than this threshold (i.e., further away from stack emissions) are not expected to be adversely affected. Therefore, the study area was determined to be the area within which there is a potential to exceed the threshold assuming continued operation of NGS from 2020 through 2044 (Environ 2014a,b). To ensure that human health and the environment are protected, the defined deposition threshold was conservatively based on 10 percent of the lowest selenium ecological soil screening level (10 percent of 0.52 milligrams selenium per kilogram soil or 0.052) protective of the most sensitive ecological receptor reported in USEPA Guidance (USEPA 2007). Note that a screening level is a numeric standard that allows quick and easy determination of whether concentrations of hazardous chemicals represent a potential risk and/or require further evaluation. This threshold also is protective of human health receptors that have a USEPA Regional Screening Level for selenium of 39 milligrams selenium per kilogram soil (USEPA 2015) that is protective of residential exposure to soil, and is greater than 100-times higher (less conservative) than the ecological soil screening level. The results indicated the deposition area (where selenium deposition exceeds 52 micrograms of selenium per square meter of soil per year) to be within a 16-km radius of the source. The 16-km radius was conservatively rounded upward to a 20-km radius, which is defined as the NGS Near-field study area (**Figure 3.0-5**).

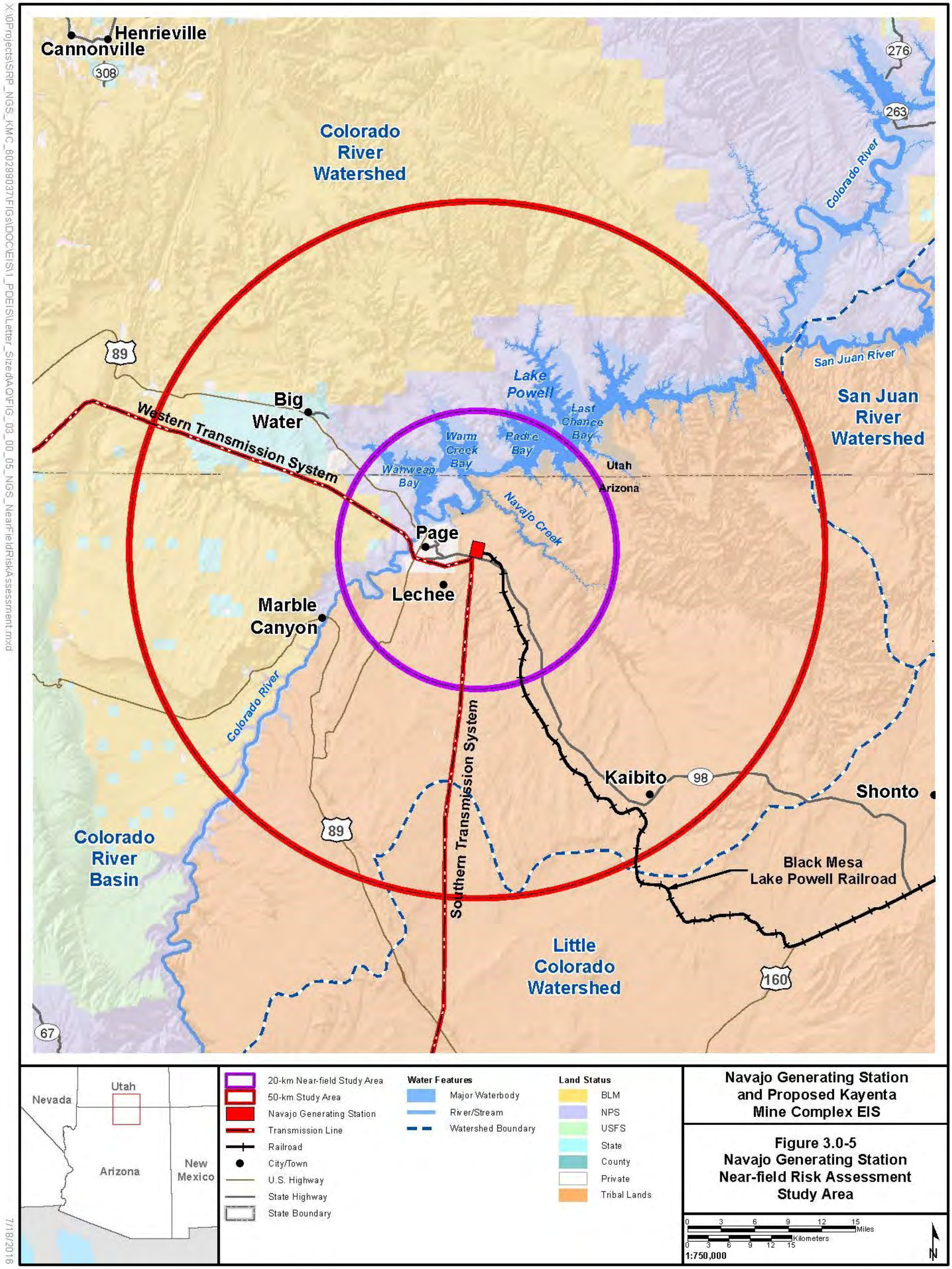


Figure 3.0-5
Navajo Generating Station Near-field Risk Assessment Study Area

The 20-km extent of the study area was subsequently verified by consideration of soil background data collected within a 20-km radius of NGS (Ramboll Environ 2016f) in combination with the AERMOD data deposition profile for selenium (Environ 2014a). Inclusion of the selenium soil background concentration (representative of both human-caused and natural existing conditions) to develop the threshold level addresses the incremental (annual) deposition of selenium to the environment while also conservatively accounting for the contribution from background conditions. Based on the AERMOD data deposition profile for selenium reported by Environ (2014a) and with consideration of selenium soil background, the selenium deposition threshold protective of ecological and human health receptors was determined to be 325 micrograms selenium per square meter of soil per year. This level was determined without the conservative adjustment by 10 percent because it considered both site-specific AERMOD data (Environ 2014a; Ramboll Environ 2016a) and background soil conditions. The preliminary study area extent (20-km radius from NGS) that was originally applied, used a screening air model without background soil consideration. These results indicated a deposition area of about a 3-km radius from the NGS stacks, well within a 20-km radius study area defined for the NGS.

The NGS Near-field study area was used to evaluate both ecological and human health risk. The remaining extent of the AERMOD domain (i.e., from 20 km to 50 km from NGS) also was considered in the human health evaluation to assess inhalation exposure. Specific details regarding how AERMOD model's predicted output concentrations were used is described within the context of the ERA and HHRA reports. Those reports are briefly described in Section 3.0.2.1 and Section 3.0.2.2, respectively.

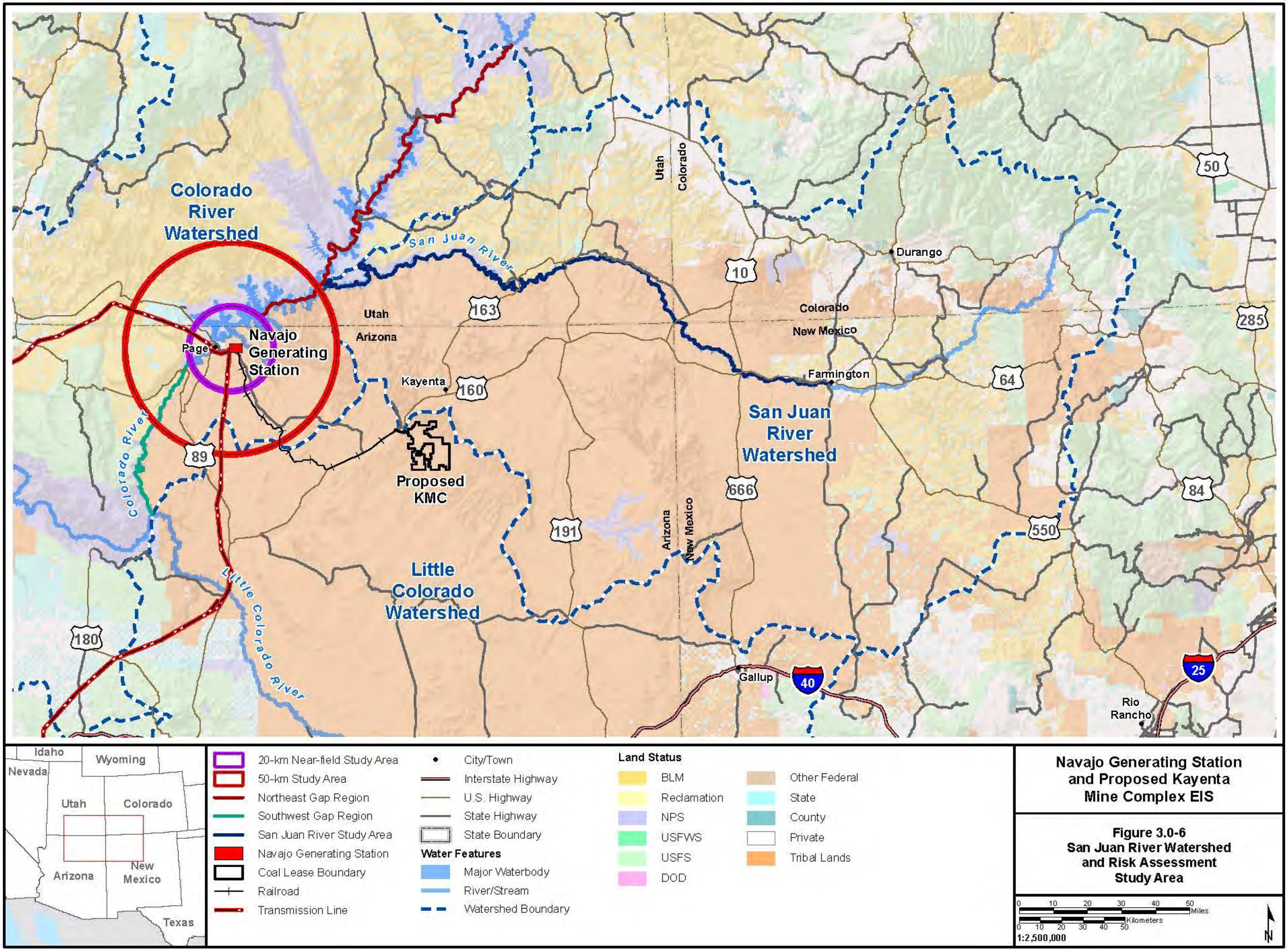
3.0.3.1.2 San Juan River

EPRI conducted a watershed-scale assessment of trace metal deposition and dynamics within the San Juan River watershed attributed to emission of arsenic, mercury, and selenium from three regional power plants (NGS, San Juan Generating Station, and Four Corners Power Plant). Atmospheric modeling of arsenic, mercury, and selenium was conducted using a suite of regional air quality models and the output was incorporated into a watershed biogeochemical cycling and aquatic biota bioaccumulation model to estimate arsenic, mercury, and selenium concentrations in surface water and mercury concentrations in invertebrate and fish tissue. Modeling estimates included contributions of local, regional, and global sources in the San Juan River Basin extending downstream and into the San Juan arm of Lake Powell. **Figure 3.0-6** depicts the San Juan River watershed within the domain of the EPRI model. The methods used to develop the models are summarized in the EPRI report (EPRI 2016). The San Juan River study area was included in the evaluation of ecological risk only because the indirect effects would contribute to and could result in potential cumulative impacts (Ramboll Environ 2016b).

3.0.3.1.3 Gap Regions

Analysis of the Gap Regions (Ramboll Environ 2016c) was conducted to address potential risks to aquatic and aquatic-oriented wildlife in the Colorado River upstream and downstream of Lake Powell, in areas that were not specifically evaluated in the NGS Near-field or San Juan River ERAs. The Gap Regions study area and chemicals of concern (arsenic, mercury, and selenium only) were defined based on consultation with U.S. Fish and Wildlife Service and other cooperating agencies to address habitat for several special status fish species. The two Gap Regions, for which one ERA was prepared, fall outside of the 20-km NGS Near-field study area and San Juan River study area. The two study areas are depicted in **Figure 3.0-7** and include:

- **Northeast Gap Region.** This includes the portion of Lake Powell beyond the 20-km NGS Near-field study area and the Colorado River northeast of Lake Powell upstream to the confluence of the Colorado and Green rivers (approximately 274 km upstream of the Glen Canyon Dam).


Colorado River Watershed
San Juan River
Utah
Colorado
Durango
Utah
Arizona
Navajo Generating Station
Page
Kayenta
Colorado
New Mexico
Farmington
San Juan River Watershed
Proposed KMC
Colorado River
Little Colorado River
Little Colorado Watershed
Arizona
New Mexico
Gallup
Rio Rancho
50
10
163
285
160
64
89
666
84
191
550
180
40
25
Idaho
Wyoming
Nevada
Utah
Colorado
Arizona
New Mexico
Texas
20-km Near-field Study Area
50-km Study Area
Northeast Gap Region
Southwest Gap Region
San Juan River Study Area
Navajo Generating Station
Coal Lease Boundary
Railroad
Transmission Line
City/Town
Interstate Highway
U.S. Highway
State Highway
State Boundary
Water Features
Major Waterbody
River/Stream
Watershed Boundary
Land Status
BLM
Reclamation
NPS
USFWS
USFS
DOD
Other Federal
State
County
Private
Tribal Lands
Navajo Generating Station and Proposed Kayenta Mine Complex EIS
Figure 3.0-6
San Juan River Watershed and Risk Assessment Study Area
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0 10 20 30 40 50 Kilometers
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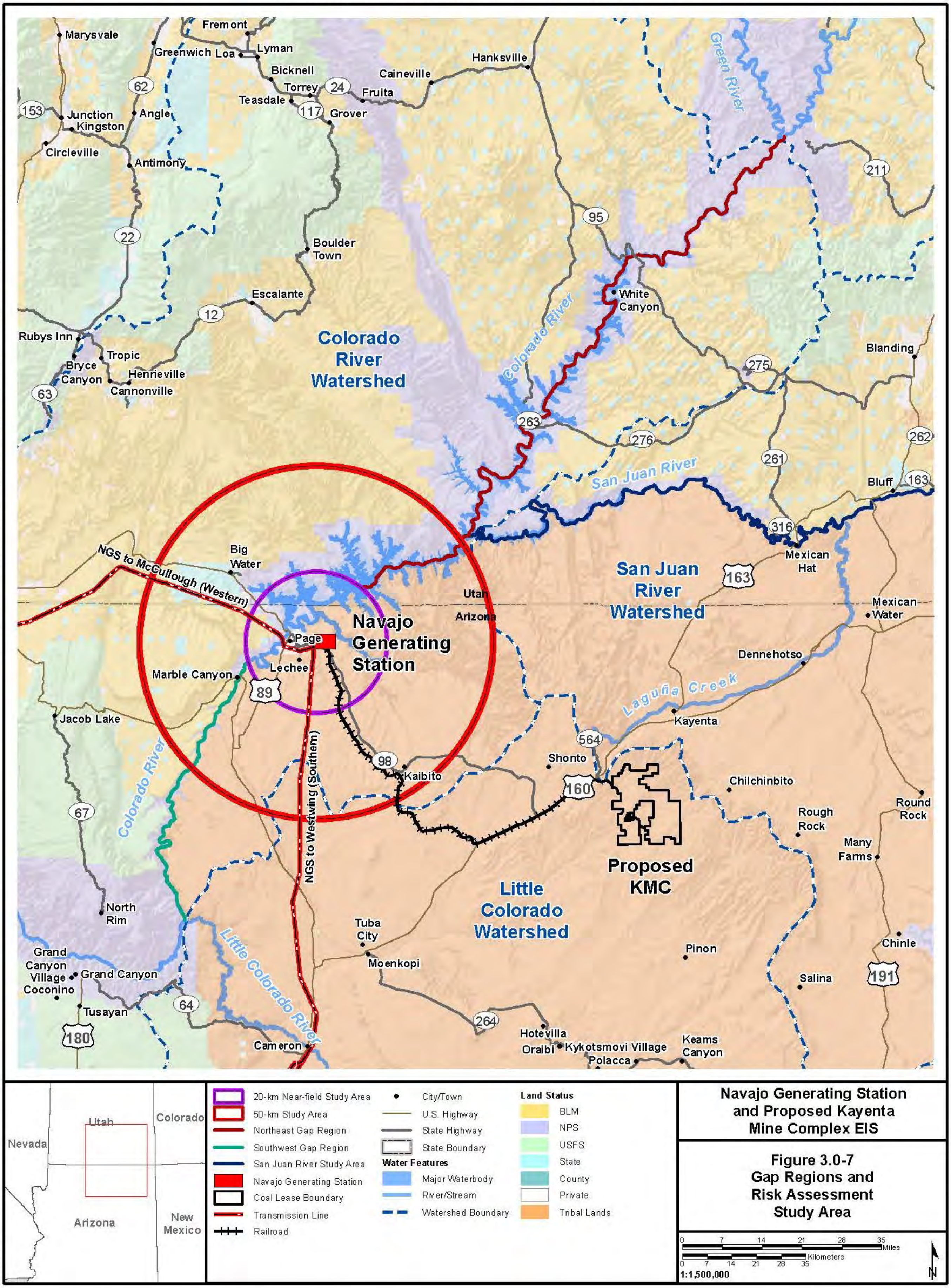

Figure 3.0-7 Gap Regions and Risk Assessment Study Area

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- **Southwest Gap Region.** This includes the lower Colorado River downstream of the 20-km NGS Near-field study area, from Lees Ferry to the confluence of the Colorado and Little Colorado rivers (approximately 100 km downstream of the Glen Canyon Dam).

The Gap Regions study area was included in the evaluation of ecological risk to account for the indirect effects that potentially add to the cumulative impacts.

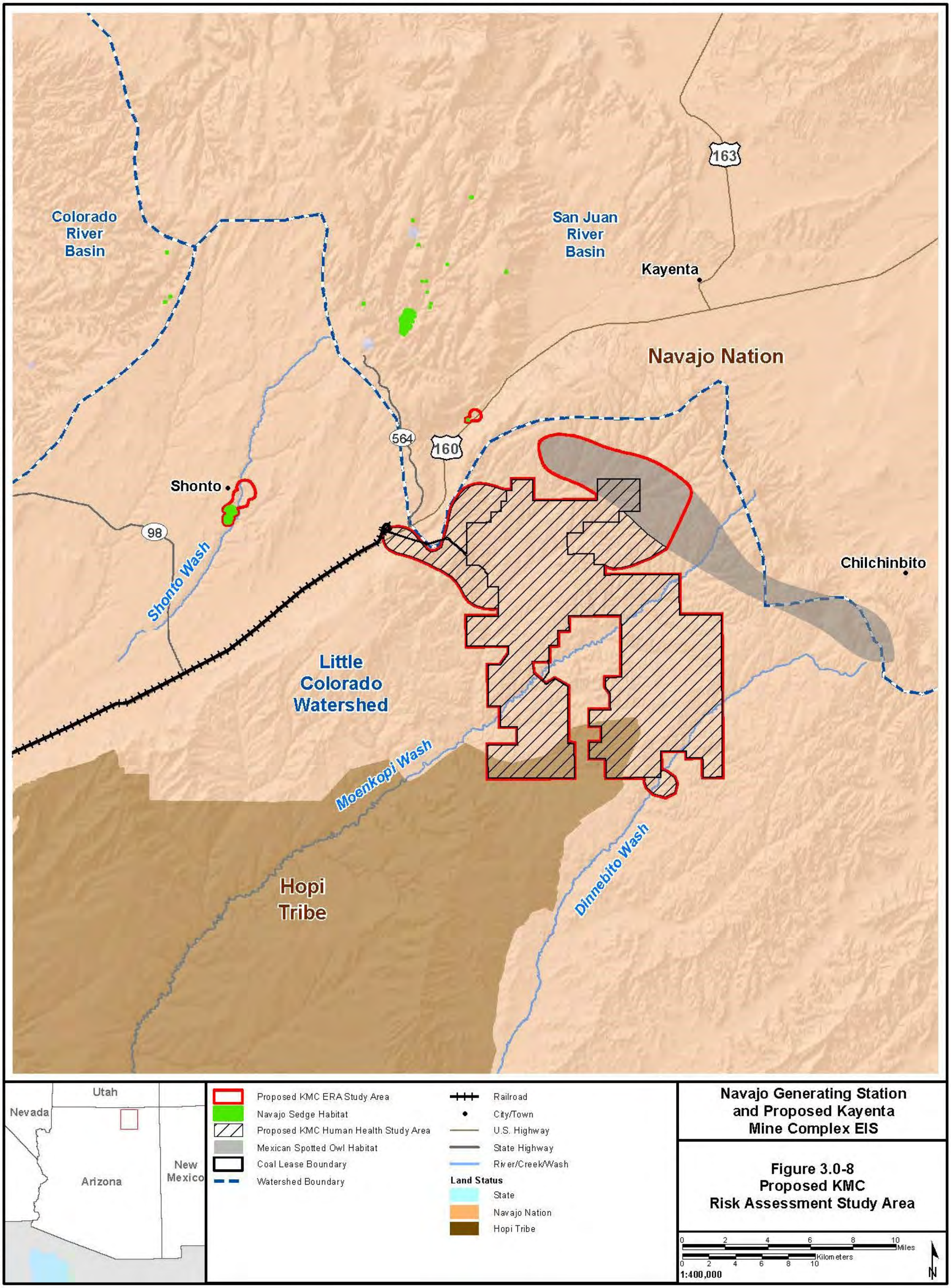
3.0.3.1.4 Proposed KMC

The proposed KMC study area was based on consideration of the existing lease property boundaries, the influence of active and proposed future mining activities (deposition area), the presence of human residential areas, and the presence of special status species and important ecological features (Flatirons Toxicology 2015a; Ramboll Environ 2016d). This area includes key ecological habitats (e.g., seeps and springs), soil, sediment, locations of special status species (i.e., Navajo sedge and Mexican spotted owl), and surface water features that may be affected by potential transport off-site (i.e., via overland flow and/or wind-generated erosion, via groundwater and other release and transport mechanisms). The study area boundaries were determined in consultation with cooperating agencies and are depicted in **Figure 3.0-8**.

The proposed KMC study area was determined based on air dispersion and deposition modeling conducted by McVehil-Monnett Associates, Inc. The modeling evaluated air impacts in a 40-km x 40-km grid from the lease permit center of the proposed KMC (McVehil-Monnett Associates, Inc. 2016). The AERMOD and NONROAD air models evaluated the emission/deposition of contaminants from mine operations through 2044 assuming continued mining operations necessary to provide coal for power generation at NGS. The model results indicated that total suspended particulate emissions were the primary source of emission sources at the proposed KMC, which may be generated from mining/pit activities, handling of topsoil, overburden (i.e., soil layer overlying coal deposits) and coal, coal processing, pit reclamation, and road travel. Heavy equipment tailpipe emissions from the mining operations and coal/coal overburden transport were modeled using the NONROAD model (McVehil-Monnett Associates, Inc. 2016) and was identified as a secondary emission source. Assuming a reasonably anticipated future maximum emission scenario (8.1 million tpy, the highest coal production scenario), the extent of impacts from proposed KMC emission sources was determined to be limited to areas within and adjacent to the lease boundary as indicated by selenium deposition contours at 52 micrograms per square meter per year, the threshold that was used in the proposed KMC ERA Study Plan to define the study area. The extent of deposition along with information regarding potential receptors, site-specific exposure scenarios and ecological attributes were used to guide the field sampling effort to obtain data necessary to support both the HHRA and ERA.

3.0.3.2 Ecological Risk Assessments

Four ERAs were conducted to evaluate the potential for adverse effects to ecological receptors. Representative ecological receptors observed or expected to occur locally or regionally were selected to evaluate the potential for adverse effects due to current and/or proposed future operation of NGS and the proposed KMC (and the combined impact of both project components). The biological organisms evaluated included terrestrial wildlife and soil communities (plants and soil invertebrates), aquatic-oriented wildlife, aquatic communities (plants, invertebrates and fish), and specific special status species (e.g., federally endangered or threatened species). The time frame for analysis was 2020–2074 to capture the indirect effects of NGS emissions and other cumulative emissions, accounting for the time it could take NGS and cumulative emissions in 2044 to deposit and move through the various ecosystems. The four assessments conducted include:



Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 3.0-8
Proposed KMC
Risk Assessment Study Area

- **NGS Near-field ERA:** The NGS Near-field ERA evaluated existing baseline conditions and potential future environmental conditions in the vicinity of NGS (Ramboll Environ 2016a). Baseline conditions were estimated from soil, surface water and sediment data collected in summer 2014 within the 20-km study area defined for the ERA. These baseline data, especially soil data, are considered representative of naturally occurring constituents, taken together with past cumulative emission/deposition from all potential sources, including local (which includes deposition and accumulation in soil and sediment from NGS historic operations), regional and global. The methods and results of this sampling event were reported in the NGS Near-field Sampling Investigation Report (Ramboll Environ 2016f) and form the basis for defining baseline conditions in this study area. In addition, recent literature data were considered in establishing baseline tissue concentrations for fish species that occur within the study area (Ramboll Environ 2016a). These baseline data, along with NGS emissions and other cumulative emission sources, were used to specifically evaluate the potential ecological risk in terrestrial and aquatic environments from exposure to chemicals present under baseline conditions and under future NGS and other cumulative emission scenarios.

- **San Juan River ERA:** The San Juan River ERA (Ramboll Environ 2016b) evaluated existing baseline conditions and potential future environmental conditions in the San Juan River and the potential for adverse effects to aquatic and aquatic-oriented receptors. The San Juan River ERA (Ramboll Environ 2016b) used results from the EPRI (2016) study to assess the potential future effects to receptors. Baseline conditions in the San Juan River were based on surface water, sediment and fish tissue data obtained from the literature (Ramboll Environ 2016b). EPRI (2016) integrated a multi-scaled air quality model to estimate the contributions of arsenic, mercury, and selenium to the San Juan River watershed from global, regional (western United States), and local sources, especially isolating and analyzing the deposition from NGS, the Four Corners Power Plant, and the San Juan Generating Station. The regional air model was coupled with a watershed biogeochemical cycling and aquatic biota bioaccumulation model to calculate surface water concentrations of arsenic, selenium, and mercury over space and time in the San Juan River Basin extending downstream to the San Juan arm of Lake Powell. The EPRI study also estimated fish tissue and invertebrate concentrations of mercury in federally endangered fish species (Colorado pikeminnow and razorback sucker) over time to 2074. As noted, the EPRI (2016) study was used in the ERA and also in independent analysis in cooperation with the U.S. Fish and Wildlife Service to evaluate the impacts of the project.

- **Gap Regions ERA:** The Gap Regions ERA (Ramboll Environ 2016c) evaluated existing baseline conditions and potential future environmental conditions in areas not specifically addressed by the NGS Near-field ERA or San Juan River ERA. Baseline conditions in the Gap Regions (**Figure 3.0-6**) were estimated from surface water, sediment, and fish tissue data obtained from the literature, and future conditions were based on emission/deposition data from the EPRI (2016) study (Ramboll Environ 2016c). The Gap Regions ERA was included to address U.S. Fish and Wildlife Service's request for impact information on sensitive aquatic species in areas potentially influenced by NGS but not specifically falling within the NGS or San Juan River study areas. The Gap Regions were ultimately defined in consultation with U.S. Fish and Wildlife Service and other cooperating agencies and the ERA evaluated aquatic and aquatic-oriented ecological receptors only, with a focus on special status species occurring in association with the Northeast and Southwest Gap Regions. Chemicals of potential ecological concern were focused on arsenic, mercury, and selenium.

- **KMC ERA:** The KMC ERA evaluated existing baseline conditions and potential future environmental conditions in the vicinity of the proposed KMC (Ramboll Environ 2016d). Baseline conditions were estimated from soil, and sediment data collected in summer 2014 within the study area defined for the ERA and surface water data obtained from the PWCC Historical Water Quality Monitoring Program. These baseline data, especially soil data, are considered representative of past cumulative emission/deposition from all potential sources, including local ground-level emissions (fugitive dusts), and regional and global emission/deposition associated with coal combustion. The methods and results of this sampling event were reported in the proposed KMC Sampling Investigation Report (Ramboll Environ 2016g) and, along with surface water monitoring data provided by PWCC, form the basis for defining baseline conditions in this study area. These baseline data, along with ground-level dust emissions and other cumulative emission sources, were used to specifically evaluate the potential ecological risk in terrestrial and aquatic environments from exposure to chemicals present under baseline conditions, and under future NGS and other cumulative emission scenarios.

The ERAs quantified chemical risk for representative ecological receptors. The receptors were selected based on ecological conceptual site models, which graphically and narratively describe the relationship between potential source, release mechanisms (e.g., aerial deposition or wind-generated dusts), and environmental exposure to potential animal and plant receptors. Risk characterization is the estimation and description of risk based on the exposure and toxicity assessments but also considers the uncertainties associated with the estimation and description of risk (USEPA 1999, 1998, 1997). In accordance with USEPA guidance, two primary estimates of risk screening and refined risk, discussed subsequently were developed for the ERAs to estimate exposure and risk to plants and animals, and used to provide a range of potential risk at NGS and associated facilities and the proposed KMC (Ramboll Environ 2016a,b,c,d).

Due to the nature of the ERAs, in which each considers a baseline scenario as well as future scenarios, all chemicals of potential ecological concern and receptors were retained throughout the ERA process (i.e., no chemicals of potential ecological concern-receptor pairs were dismissed prior to completion of all applicable scenarios) (Ramboll Environ 2016a,b,c,d). This allows for a total cumulative risk estimate that considers baseline, NGS or proposed KMC future contribution and other cumulative sources.

The outcome of the refined evaluation represents a scientific management decision point (USEPA 1997) in which the conclusion of acceptable or unacceptable ecological risk is used to guide risk management decisions or define additional data needs to further characterize risk.

3.0.3.2.1 ERA Process and Applicability to the EIS Process

Screening and refined evaluations in the context of the overall ERA process, key risk assessment concepts, and the applicability of the ERAs to the EIS process are discussed in this section. Additional information summarizing methods and results of the ERAs is provided in **Appendix 3RA** and full details are provided in each of the ERA reports (Ramboll Environ 2016a,b,c,d).

For ecological community-level receptors, the potential risk is estimated by direct comparison of measured concentrations of chemicals of potential ecological concern in soil, sediment, surface water, or fish tissue to their respective screening level or benchmark toxicity values, collectively referred to as ecological screening values. These comparisons apply to terrestrial plants and invertebrates exposed to soil, and aquatic organisms (i.e., fish, other aquatic animals, and aquatic plants) exposed to surface water and/or benthic zone organisms exposed to sediment.

The exposure assessment presents the assumptions and parameters used to develop estimates of exposure. Per USEPA ERA guidance (USEPA 1998, 1997), the ERA is an evaluation based on generally conservative assumptions and is intended to eliminate from further study, chemicals of potential ecological concern having no potential to cause risk, and identify those chemicals of potential ecological concern and receptors that require further evaluation. Risk assessment is typically conducted in a tiered, step-wise manner to maximize the use of available site and receptor-specific information while providing the opportunity, with each tier of evaluation, to reduce and minimize uncertainties that are inherent in the ERA process. As indicated above, the screening evaluation is the first tier of the process and provides a conservative estimate of exposure based on maximum environmental chemicals of potential ecological concern concentrations and the assumption that a given receptor is exposed to such concentration for its entire life. This exposure assumption is generally not realistic in nature because it assumes a given receptor is exposed continuously to only a maximum concentration, even though in general, wildlife and associated plant and animal communities are typically exposed over a wider range or habitat within which their exposure is best represented as an average. Therefore, this first tier of the ERA process is intended to eliminate chemicals (and receptors) for which exposure is considered to have no effect. The refined evaluation allows for "refinement" of chemicals of potential ecological concern identified in the initial screening (USEPA 1998, 1997) and is focused on identification and characterization of current and future risk using site-specific assumptions regarding exposure. For the NGS ERAs, the key exposure assumption that defines the screening and refined evaluations is the chemicals of potential ecological concern concentration or exposure point concentration that is used (soil, surface water, sediment or fish tissue concentration to which ecological receptors are exposed). Exposure point concentrations are estimates of the representative exposure concentration of chemicals of potential ecological concern in a given study area. In the screening evaluation, the exposure point concentration is the maximum detected concentration. In the refined evaluation, the 95 percent upper confidence limit of the arithmetic mean for soil, surface water, sediment and fish tissue is used if it can be calculated. The 95 percent upper confidence limit of the arithmetic mean is calculated using USEPA's statistical tool ProUCL version 5.0.00 (USEPA 2013) wherever the number of sample points (i.e., six or more samples) and chemicals of potential ecological concern detections were sufficient to compute the 95 percent upper confidence limit of the mean; otherwise, the maximum detected concentration was applied in the refined evaluation. A simple arithmetic average concentration also may be considered in the refined evaluation as an additional line of evidence to characterize exposure.

The toxicity assessment identifies appropriate toxicity data for use in the ERA and evaluates toxicity and provides other effects information to correlate impairment of health exposure to ecological receptors. Toxicity reference values and ecological screening values correlate a specified effect to a given chemical concentration and are used to characterize potential ecological effects. The toxicity data used to evaluate ecological risks resulting from chemical exposure are available in ecological risk assessment guidance and state, federal, and literature sources and typically are derived from single-chemical toxicity studies. The toxicity data and exposure parameters used to develop risk estimates were presented in each of the ERAs developed for this project (Ramboll Environ 2016a,b,c,d). The toxicity data considered include ecological screening values that are based on no observed effect concentrations and are used to evaluate biological communities (aggregate populations of organisms), and no observed adverse effect level toxicity reference values that are used to evaluate wildlife. In addition, fish tissue critical body residues are used to evaluate toxicity to fish. The critical body residue is a fish tissue concentration that is protective of fish health. Toxicity data used for the screening evaluation are generally based on no effect data (no observed effect concentration/no observed adverse effect level) that are considered protective of individual organisms and, by default, organism populations. For the refined evaluation, a lowest observed adverse effect level toxicity reference value also may be considered if risk thresholds were exceeded using the no observable adverse effect level. These latter toxicity data are considered protective of organism populations.

The following summarizes the key exposure media and exposure and toxicity assumptions applied for all ERAs in each tier of evaluation:

- Screening Evaluation – uses the maximum detect concentration in soil, surface water, sediment and fish tissue (where available), no observed effect concentration/no observed adverse effect level toxicity data, and assumes all mammals and most birds are present within a defined study area for their entire life (area use is 100 percent). Because the screening evaluation uses maximum concentrations of chemicals of potential ecological concern and conservative exposure parameters it provides a conservative (overly protective) estimate of exposure.
- Refined Evaluation – uses the 95 percent upper confidence limit (or maximum detected concentration if a 95 percent upper confidence limit could not be calculated) in soil, surface water, sediment and fish tissue (where available), no observed effect concentration/no observed adverse effect level toxicity data, and assumes all mammals and most birds are present within a defined study area for their entire life (area use is 100 percent). Lowest observed effect concentration/lowest observed adverse effect level toxicity data also are considered on a case

by case basis, and arithmetic average concentrations also are considered in the refined evaluation.

In both tiers of evaluation, for those wildlife receptors (birds) that have large feeding ranges (larger than the study area) and/or migrate in/out of a given study area seasonally, an area use factor and exposure duration, respectively, are considered and the same values used for screening and refined evaluations. In addition, uptake factors (used to estimate wildlife tissue concentration of chemicals of potential ecological concern from soil, surface water and/or sediment) are based on estimated average exposure, and receptor-specific life history parameters (e.g., body weight, food intake rate, dietary preference and components, feeding range and exposure duration/migration) are the same for both screening and refined evaluations.

Risk estimation uses quantitative methods to evaluate the potential for risk, which are presented as screening level hazard quotients (hazard quotient$_{max}$) and refined hazard quotients (hazard quotient$_{refined}$). For screening and refined evaluations, risk estimates are developed for each receptor using the defined measures of exposure (medium-specific exposure point concentrations and receptor exposure parameters) and effect (chemical-specific toxicity reference values) for each exposure scenario. For wildlife evaluations, toxicity reference values based on no observed adverse effect levels are considered for both the maximum exposure scenario risk estimates (no observed adverse effect level hazard quotient$_{max}$) and refined exposure scenario estimates (no observed adverse effect level hazard quotient$_{refined}$). For the refined exposure scenario, a lowest observed adverse effect level also may be considered if further evaluation is warranted (lowest observed adverse effect level hazard quotient$_{refined}$). Refined risk description considers the quantitative risk estimates and, along with other lines of evidence (e.g., habitat and vegetation quality, consideration of background conditions, receptor diet) and potentially affected receptor groups, serves to identify chemicals for additional consideration in additional tiers of evaluation and/or for consideration for risk management. For special status species (especially federal or state listed species), hazard quotients based on toxicity data protective of individual organisms (no observed effect concentration or no observed adverse effect level) are most applicable and so no observed adverse effect level hazard quotient$_{refined}$ and no observed adverse effect level hazard quotient$_{max}$ are relevant for these receptors. For non-special status species, hazard quotients based on toxicity data protective of organism population (lowest observed adverse effect level or lowest observed effect concentration) are most relevant.

The hazard quotient is a unitless value that relates the measured (or modeled using uptake factors) concentration in site media (e.g., soil) to a known literature-based toxicity level expressed in the same units of measure (e.g., milligrams per kilogram) and is calculated as follows:

$$HQ = \frac{Maximum\ Detected\ Concentration\ or\ 95\%\ UCL}{Ecological\ Screening\ Value\ (ESV)}$$

Chemical concentrations in excess of literature-based toxicity levels indicate a potential for adverse effects to a given community. In general, media-specific concentrations less than or equal to the applicable ecological screening value (typically based on a no effect level) are unlikely to result in impairment of health for ecological receptors and can be effectively eliminated from further consideration. The risk estimates for community level receptors (organism populations), based on comparison of applicable ecological screening values (protective of organism health) to medium-specific concentrations, may be interpreted as follows:

- HQ_{max} less than or equal to 1
  - Ecological risk is highly unlikely
  - No further concerns

- $HQ_{refined}$ less than 1 but HQ_{max} greater than 1
  - Ecological risk to individual organisms possible
  - Ecological risk to organism populations is unlikely or negligible
  - Evaluate other lines of evidence (e.g., background conditions) to draw conclusions
- $HQ_{refined}$ greater than 1
  - Ecological risk to community/population may be possible
  - Evaluate other lines of evidence (e.g., background conditions) to draw conclusions

For birds and mammals, the risk estimate is based on a hazard quotient defined as the ingested dietary dose (i.e., the intake of chemicals in soil or sediment, food, and water) divided by the chemical-specific toxicity reference value expressed in the same units of measure (i.e., milligrams food/water per kilogram body weight per day):

$$HQ = \frac{Dietary\ Dose}{Toxicity\ Reference\ Value}$$

Food web biotransfer from contaminated media to biota is based on assumptions that generally result in conservative estimates of exposure dose.

For bird and mammal evaluations, the hazard quotient may be interpreted as follows:

- No observed adverse effect level hazard $quotient_{max}$ is less than or equal to 1
  - Ecological risk is highly unlikely.
  - No further concerns.
- No observed adverse effect level hazard $quotient_{max}$ greater than 1 but no observed adverse effect level hazard $quotient_{refined}$ less than 1
  - Ecological risk to individual organisms possible.
  - Ecological risk to organism populations is unlikely or negligible.
  - Evaluate other lines of evidence (e.g., background concentrations) to draw risk conclusions.
- No observed adverse effect level $HQ_{refined}$ greater than 1 but lowest observed adverse effect level $HQ_{refined}$ less than 1
  - Ecological risk to individual organisms possible
  - Ecological risk to population is low or negligible
  - Evaluate other lines of evidence (e.g., background conditions) to draw conclusions
- Lowest observed adverse effect level hazard $quotient_{refined}$ greater than or equal to 1
  - Ecological risk may be present.
  - Proceed to risk management and/or consider additional lines of evidence and/or studies to further refine risk estimate.

The hazard quotient is not a predictor of risk but rather is a tool used to screen out chemical exposure to receptors where there is no harm indicated, and to identify chemicals for which additional evaluation may be required (Allard et al. 2009; USEPA 1997). The numeric HQ estimates generated also are considered, where applicable, with other lines of evidence to reduce the uncertainty in the estimate to draw conclusions regarding risk. Lines of evidence may include, but are not limited to, consideration of naturally occurring and/or human-caused background conditions, review of presence, absence and/or quality of habitat, consideration of supplemental toxicity data. Such lines of evidence are discussed in detail in the uncertainty analysis of the risk assessment reports (Ramboll Environ 2016a,b,c,d). An overview of key uncertainties is provided in **Appendix 3RA**.

For purposes of EIS analysis, the predicted hazard quotient values for defined representative ecological receptors (species or species groups) are used as indicators to determine whether risk is negligible or possible. Other factors influencing the health of individual species populations also are considered in the impact analysis. It is important to reiterate that all chemicals of potential ecological concern and receptors were carried through the entire ERA process, which includes evaluation of multiple primary scenarios: baseline, NGS or proposed KMC emissions, and other cumulative sources. So, the HQs presented in the subsequent resource-specific sections (wildlife, vegetation, and aquatic resources) are focused to the receptors and chemicals of potential ecological concern where HQs, considering all three scenarios together (total cumulative), indicate that risk is possible or unknown. Each scenario is then discussed as it pertains to the Affected Environment and Environmental Consequences discussions in Sections 3.8 through 3.13. **Appendix 3RA** provides an overview summary the ERA process and resulting risk estimates for each ERA conducted.

3.0.3.3 Human Health Risk Assessments

Human receptors could be exposed to project-related residual chemicals present in air, soil, water, sediment, and food in the area under current conditions. The sources of these chemicals in environmental media may include past and future NGS and mining operations; regional emission sources including but not limited to the Four Corners Power Plant and San Juan Generating Station; municipal, industrial and agricultural emissions and/or runoff; global emission sources; and naturally occurring conditions.

Two HHRAs were conducted to evaluate the potential for adverse effects to human populations that are present locally or regionally that could be affected by current or proposed future operation of NGS and the proposed KMC. The study areas for the HHRAs include the area up to 50 km from the NGS and up to a distance of approximately 50 km from the center of the proposed KMC lease permit boundary, as reflected in the dispersion modeling that was used to evaluate impacts. The NGS and proposed KMC air models were used as inputs to calculate ambient air concentrations and deposition for the respective projects. In addition, the combined impacts of NGS and proposed KMC operations on each other were analyzed and considered.

For both the NGS and proposed KMC, the HHRA process for identifying COPCs focused on substances associated with facility operations, standard risk-based environmental concentrations of concern, and potential background sources of the substances (e.g., typical environmental concentrations of naturally occurring metals). For the NGS HHRA, the selected COPCs are those typically associated with coal-fired power generation (including both stack and fugitive emissions) as well as diesel vehicle traffic. The KMC HHRA focused on COPCs generated during coal mining, handling, and transport by diesel trucks and other vehicles. For both facilities, the list of COPCs included polycyclic aromatic hydrocarbon compounds, diesel particulate matter, criteria air pollutants and approximately 20 metals. The NGS HHRA also considered dioxins and furans, volatile compounds and acid gases (Gradient 2016).

The human health risk assessments included:

- **NGS HHRA:** This HHRA evaluated existing baseline conditions (2019) and prospective future environmental conditions through 2044 for ambient air impact and through 2074 for deposition impacts in the vicinity of NGS (Ramboll Environ 2016e,f). The HHRA was conducted to specifically evaluate potential risk to human health from potential exposure to chemicals present in environmental media and those dispersed from stack emissions and other NGS sources within the area identified by air dispersion modeling (AERMOD) (i.e., within a 50 km radius of NGS), proposed KMC emissions, and regional/global sources.

- **KMC HHRA:** This HHRA evaluated existing baseline conditions (2019) and prospective future environmental conditions in the vicinity of the proposed KMC (Flatirons Toxicology, Inc. 2015a,b). The HHRA was conducted to specifically evaluate the potential for adverse effects to human health from potential exposure to existing chemicals currently present in environmental media and those potentially dispersed from modeled ground level emission sources associated with proposed future mining operations through 2044 plus two years of active reclamation work, NGS stack and secondary emissions, and regional/global sources.

For these evaluations, background and incremental (i.e., risk above expected background) lifetime cancer risks and non-cancer hazard indices were evaluated for individuals who may reside, work, or recreate within 50 km of NGS, and individuals that reside in the vicinity of the proposed KMC. Each risk assessment was performed as a separate evaluation with a unique set of receptors and sampling data, and evaluated adverse health endpoints for baseline (i.e., currently existing conditions in the vicinity of the facilities), Proposed Action (i.e., conditions predicted in the vicinity of the facilities as a result of future facility operations and emissions), combined impacts (NGS + proposed KMC, proposed KMC + NGS), and other cumulative sources (i.e., potential exposures and risks associated with other regional and global sources of three specific chemicals–arsenic, mercury and selenium).

3.0.3.3.1 HHRA Process and Applicability to the EIS Process

The hazard identification and exposure and toxicity assessments present the exposure and toxicity data necessary to develop risk estimates in the risk characterization step. The HHRA calculates two types of risk estimates for each receptor population relevant for evaluation: incremental lifetime cancer risks and non-cancer hazard quotients for each COPC and receptor.

For carcinogens (known or potential cancer-causing chemicals), the risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure over some defined exposure interval (e.g., an estimated exposure interval over a lifetime of 70 years). Calculated results (cancer risk estimates) are compared to USEPA acceptable incremental target cancer risks, with a cancer incidence (i.e., rate of occurrence) of one in ten thousand (i.e., 1/10,000) to an incidence of one in one million (i.e., 1/1,000,000) (USEPA 1990). Cancer risk of one in one million means that in a population of one million people, not more than one additional person would be expected to develop cancer as the result of the exposure to a given substance causing that risk. One in one million risk of cancer from life-long exposure to a hazardous chemical represents an “acceptable risk” level because the risk is comparable but below the overall lifetime probability of an individual developing cancer in the United States of 1 in 2 for males and 1 in 3 for females (American Cancer Society 2015). Individual chemical cancer and/or cumulative cancer risks (i.e., sum of cancer risk for multiple chemicals) are calculated, and cancer risks exceeding one in ten thousand generally are considered unacceptable. This typically would warrant remedial action to reduce or control potential risk (USEPA 1991). Individual COPC cancer risks are calculated as the total intake (e.g., via diet, and/or dermal exposure) times the cancer toxicity value that is applicable to the pathway of exposure (i.e., cancer slope factor for dietary and dermal exposure) (USEPA 2004). Based on USEPA guidance (USEPA 2009), air concentrations of COPCs rather than COPC intakes were used to evaluate inhalation risk. The quantitative cancer risk calculations for the air inhalation route of exposure integrate exposure concentrations and toxicity. The general equation for cancer risk is:

$$Cancer\ Risk = Intake\ x\ Cancer\ Toxicity\ Value$$

The individual COPC cancer risks are then added together to obtain a cumulative cancer risk estimate for each relevant receptor group (e.g., residents).

Quantitative evaluation of potential non-cancer human health risk is determined by comparing the actual level of exposure to a chemical (intake), to a level of exposure that is not expected to cause any adverse effects (e.g., asthma, birth defects, nervous system disorders), even in the most susceptible populations. These non-cancer, no effect levels are referred to as either reference doses (based on exposure in food or water) or reference concentrations (based on exposure in air) to determine a hazard quotient, a quantitative estimate of non-cancer health risks. The quantitative non-cancer risk calculations for the air inhalation route of exposure integrate exposure concentrations and toxicity rather than COPC intakes. The general equation for noncancer risk is:

$$HQ = \frac{Intake}{Reference\ Dose\ or\ Reference\ Concentration}$$

A hazard quotient is derived for each COPC. The hazard quotients for each COPC are then summed to derive a cumulative hazard index (HI) for all chemicals for each exposure pathway as well as a total HI for all exposure pathways. If a hazard index is less than 1, then the exposures are considered to be acceptable, i.e., no adverse human health effects are expected to occur, for non-cancer risk and no further risk evaluation is warranted. The hazard index is calculated using the following equation:

$$HI = HQ_{COPC1} + HQ_{COPC2} + HQ_{COPC3...}$$

When a hazard index exceeds 1, a target organ analysis is performed. A target organ is the primary or most sensitive organ (e.g., liver, kidney, or lung) where a chemical causes non-cancer toxic effects. A target organ analysis evaluates chemicals that have similar modes of toxicological action or similar impacts on an organ or system of the body. Such chemicals are grouped together to calculate a target organ-specific hazard quotient/hazard index. If the hazard quotient/hazard index is less than 1 for a given target organ, then adverse health effects would not be expected and the analysis is complete. Calculating risk based on a target organ analysis reduces the possibility of overestimating risk by summing hazard quotients for a mixture of chemicals that are not expected to induce the same types of effects on a specific target organ.

For purposes of EIS analysis, the estimated hypothetical cancer risk, hazard quotient and hazard index values for different exposed members of the public are used as indicators of acceptable or unacceptable risk. Other factors influencing the health of individuals and groups of people also are considered in the impact analysis.

3.0.3.4 References

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Appendix 3RA

Summary of Risk Assessments Conducted in Support of the NGS-KMC EIS

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Section 3.1

Air Quality

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Acronyms and Abbreviations

$\mu g/m^3$	micrograms per cubic meter
1969 Lease	Navajo Project Indenture of Lease
As	arsenic
BART	Best Available Retrofit Technology
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BM&LP Railroad	Black Mesa & Lake Powell Railroad
BO	Biological Opinion
CAMx	Comprehensive Air Quality Model with Extensions
CAP	Central Arizona Project
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CO	carbon monoxide
CO_2	carbon dioxide
Co-tenants	Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
Development Fund	Lower Colorado River Basin Development Fund
EIS	Environmental Impact Statement
ERA	Ecological Risk Assessment
ESA	Endangered Species Act of 1973
HAP	Hazardous Air Pollutant
Hg	mercury
HHRA	Human Health Risk Assessment
kg	kilogram
km	kilometer
KMC	Kayenta Mine Complex
kV	kilovolt
kW	kilowatt
MW	megawatt
NAAQS	National Ambient Air Quality Standards
N-Aquifer	Navajo Aquifer
NEPA	National Environmental Policy Act of 1969, as amended
NGS	Navajo Generating Station
NGS Participants	U.S. (Reclamation), Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
NHPA	National Historic Preservation Act
NNEPA	Navajo Nation Environmental Protection Agency
NO_2	nitrogen dioxide
NO_3	nitrate
NO_X	oxides of nitrogen

OSMRE	Office of Surface Mining Reclamation and Enforcement
PFR	Partial Federal Replacement
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 microns or less
ppb	parts per billion
ppm	parts per million
PWCC	Peabody Western Coal Company
Reclamation	U.S. Bureau of Reclamation
ROW	Right-of-way
Se	selenium
SCR	Selective catalytic reduction
SO_2	sulfur dioxide
SO_4	sulfate
SRP	Salt River Project Agricultural Improvement and Power District
STS	Southern Transmission System
tpy	tons per year
U.S.	United States
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compound
WTS	Western Transmission System

Contents

3.1 Air Quality 3.1-1
3.1.1 Regulatory Framework 3.1-1
3.1.1.1 Ambient Air Quality Standards 3.1-1
3.1.1.2 Hazardous Air Pollutants 3.1-3
3.1.1.3 Regional Haze 3.1-4
3.1.2 Study Areas 3.1-4
3.1.2.1 Proposed Action and Action Alternatives 3.1-4
3.1.2.2 Cumulative 3.1-6
3.1.3 Affected Environment 3.1-6
3.1.3.1 Navajo Generating Station 3.1-6
3.1.3.2 Proposed Kayenta Mine Complex 3.1-17
3.1.3.3 Transmission Systems and Communication Sites 3.1-20
3.1.4 Environmental Consequences 3.1-20
3.1.4.1 Issues 3.1-20
3.1.4.2 Assumptions and Impact Methodology 3.1-20
3.1.4.3 Proposed Action 3.1-27
3.1.4.4 Natural Gas Partial Federal Replacement Alternative 3.1-56
3.1.4.5 Renewable Partial Federal Replacement Alternative 3.1-60
3.1.4.6 Tribal Partial Federal Replacement Alternative 3.1-65
3.1.4.7 No Action 3.1-69
3.1.5 References 3.1-70

List of Appendices

Appendix 3.1-A - Total Nitrogen and Sulfur Deposition at CASTNET Sites in Four National Parks

Appendix 3.1-B - Atmospheric Deposition Data from the National Dispersion Network Stations

Appendix 3.1-C - Proposed KMC Air Quality Monitoring Report, Summary of Quality Assurance Activities

Appendix 3.1-D - NGS Technical Workgroup Emissions Data for “Bookends” Scenarios

List of Tables

Table 3.1-1 National Ambient Air Quality Standards 3.1-2
Table 3.1-2 Summary of Hazardous Air Pollutant Regulations 3.1-3
Table 3.1-3 Existing Major Sources and Pollutant Emissions in the Study Area 3.1-7
Table 3.1-4 Monitored Air Quality Conditions in the NGS-KMC Region 3.1-9
Table 3.1-5 Visibility (Haziness) Records at IMPROVE Sites 3.1-12
Table 3.1-6 Average and Trends in Atmospheric Deposition at Clean Air Status and Trends Network Sites (1990 to 2013) 3.1-14
Table 3.1-7 Annual Average Deposition Rates At National Deposition Network Sites 3.1-15
Table 3.1-8 Monitored Air Quality Conditions at the Proposed KMC 3.1-18
Table 3.1-9 Key Assumptions Regarding Emissions Calculations at NGS 3.1-21
Table 3.1-10 Annual NGS Air Emissions from Electric Generating Units Main Boiler Stacks 3.1-29
Table 3.1-11 NGS Emissions from Other Sources – 3-Unit Operation 3.1-30
Table 3.1-12 Modeled Air Quality Impacts from AERMOD 3-Unit Operation 3.1-31
Table 3.1-13 Modeled Air Quality Impacts from AERMOD 2-Unit Operation 3.1-32
Table 3.1-14 Maximum Impact and Deposition of HAP Metals from NGS Emissions 3.1-33
Table 3.1-15 USEPA Modeling Results 3.1-34
Table 3.1-16 Particulate Matter Emission Sources, Factors, and Controls 3.1-36
Table 3.1-17 Total Emissions for the 8.1 Million tpy Production 3.1-38
Table 3.1-18 Total Emissions for the 5.5 Million tpy Production 3.1-38
Table 3.1-19 Maximum Modeled Design Concentrations at Proposed KMC Boundary and Grid Receptors 3.1-39
Table 3.1-20 Maximum Modeled Design Concentrations at Proposed KMC Residence Receptors 3.1-40
Table 3.1-21 Deposition Rates for Selected Metals from Proposed KMC Operations 3.1-44
Table 3.1-22 Proposed Action Impact Summary 3.1-46
Table 3.1-23 Cumulative Results from Near-field Modeling for Receptors 50 km from NGS 3.1-49
Table 3.1-24 Cumulative Results from Near-field Modeling for Receptors 80 km from NGS 3.1-50
Table 3.1-25 Range of Maximum Ozone Impacts of NGS Operation at Class I Areas 3.1-52
Table 3.1-26 Range of Maximum Ozone Impacts of NGS Operation at Sensitive Class II Areas 3.1-53
Table 3.1-27 Emissions and Impacts from NGS Associated with the Natural Gas PFR Alternative 3.1-57
Table 3.1-28 Emissions and Impacts of the Proposed KMC Operations Associated with the Natural Gas PFR Alternative 3.1-59
Table 3.1-29 Emissions and Impacts from NGS Associated with the Renewable PFR Alternative 3.1-61

Table 3.1-30 Emissions and Impacts of the Proposed KMC Operations Associated with the Renewable PFR Alternative 3.1-63
Table 3.1-31 Emissions and Impacts from NGS Associated with the Tribal PFR Alternative 3.1-65
Table 3.1-32 Emissions and Impacts of the Proposed KMC Operations Associated with the Tribal PFR Alternative 3.1-67
Table 3.1-33 Background Ambient Air Quality Levels at NGS Representative of the No Action Alternative 3.1-69

List of Figures

Figure 3.1-1 Air Quality Study Areas ... 3.1-5
Figure 3.1-2a-d Nearest Major Sources of Criteria Air Pollutants for NO_X, SO_2, PM_{10}, and $PM_{2.5}$ ... 3.1-8
Figure 3.1-3 Air Quality Monitoring Sites ... 3.1-10
Figure 3.1-4 Average Visibility Levels ... 3.1-13
Figure 3.1-5 Average Total Annual Wet Deposition Rate at Six National Deposition Network Sites ... 3.1-16
Figure 3.1-6 Annual Wet Sulfate Deposition at Three National Deposition Network Sites ... 3.1-16
Figure 3.1-7 Annual Total Mercury Wet Deposition at Mercury Deposition Network Sites ... 3.1-17
Figure 3.1-8 Residence Receptors at Proposed KMC ... 3.1-19
Figure 3.1-9 Wind Rose Plot for Page Municipal Airport ... 3.1-23
Figure 3.1-10 AERMOD Dispersion and Deposition Modeling Receptor Grid for NGS ... 3.1-25
Figure 3.1-11 AERMOD Dispersion Modeling Receptor Grid for Proposed KMC ... 3.1-26
Figure 3.1-12 1-hour 5-year Mean 98^{th} Percentile NO_2 Concentration ($\mu g/m^3$) for 8.1 Million tpy Production Operation in 2027 ... 3.1-41
Figure 3.1-13 24-hour 6^{th}-High PM_{10} Concentration ($\mu g/m^3$) for 8.1 Million tpy Production Operation in 2042 ... 3.1-42
Figure 3.1-14 24-hour 5-year Mean 98^{th} Percentile $PM_{2.5}$ Concentration ($\mu g/m^3$) for 8.1 Million tpy Production Operation in 2027 ... 3.1-43

3.1 Air Quality

Proposed continued Navajo Generating Station (NGS) operations and mining activities at the proposed Kayenta Mine Complex (KMC), and alternatives were evaluated against established air quality standards, air quality related values, and compared to the No Action Alternative. The regulatory framework, existing conditions, and environmental effects of the Proposed Action and action alternatives and cumulative impacts related to air quality are addressed in this section. In addition, issues raised in scoping and through other avenues were analyzed.

Air quality characterization includes a review of past and present emissions within the study area. The baseline air quality conditions are portrayed based on recent air quality monitoring data collected in the study area including data on visibility, mercury, and acid deposition. The environmental consequences of the Proposed Action were developed from a set of analyses beginning with a presentation of emissions associated with NGS and the proposed KMC as well as support operations. The emissions for the Proposed Action 3-Unit Operation and 2-Unit Operation at NGS and the associated mining operations (8.1 million tons per year [tpy] and 5.5 million tpy) at the proposed KMC are provided and compared. For each of those operations, a dispersion model and/or a photochemical grid model was used to estimate impacts on air quality, atmospheric depositions of trace metals and other compounds, and acid deposition at Class I areas. The BART analysis conducted by USEPA was used to summarize impacts on regional haze at Class 1 areas.

For the air quality and deposition analyses, the baseline or background conditions were considered and the modeled impacts were added to those conditions to depict the environmental consequences of the Proposed Action and action alternatives. Impacts at the proposed KMC also were analyzed at residences both within the mine lease area and in the immediate vicinity of the proposed KMC. A comparative impact analysis is provided for Proposed Action operations and action alternatives. The deposition and air quality impacts related to chemicals of concern were used as a basis for the ecological risk assessments and the human health risk assessments. Cumulative impacts and the No Action Alternative were also analyzed.

3.1.1 Regulatory Framework

The Clean Air Act of 1970, and its amendments in 1977 and 1990 (referred to collectively as the Clean Air Act), establishes regulatory framework that protects ambient air quality and air quality-related values, requires installation of stringent control technologies, limits emissions to the atmosphere, and provides mechanisms to ensure monitoring and compliance. The U.S. Environmental Protection Agency (USEPA) promulgates regulations to implement the Clean Air Act, and delegates various responsibilities to state and tribal governments.

3.1.1.1 Ambient Air Quality Standards

The Clean Air Act requires establishment of National Ambient Air Quality Standards (NAAQS) for criteria air pollutants across the U.S., including primary standards to protect the health of the citizens and secondary standards to protect other public welfare-related values. The Clean Air Act requires existing and proposed emission sources to demonstrate compliance with those standards. The applicable NAAQS for the seven criteria air pollutants are provided in **Table 3.1-1**, including the relevant time frame of the standards and calculation method. While some states adopt air quality standards that are more stringent than the NAAQS, the NGS is regulated by USEPA, so the federal statutes and regulations apply. USEPA has delegated the Clean Air Act's Title V operating permit program under 40 CFR Part 71 to the Navajo Nation Environmental Protection Agency.

Table 3.1-1 National Ambient Air Quality Standards

Pollutant	Standard	Averaging Time	Concentration		Statistical Form
			ppbv	μg/m^3	
Nitrogen dioxide (NO_2)	Primary	1-hour	100	188	3-year average of the annual 98th percentile highest daily 1-hour concentrations
	Primary and Secondary	Annual	53	100	Annual mean
Sulfur dioxide (SO_2)	Primary	1-hour	75	196	3-year average of the annual 99th percentile highest daily 1-hour concentrations
	Secondary	3-hour	500	1,300	Annual second highest value
Carbon monoxide (CO)	Primary	1-hour	35,000	40,000	Annual second-highest value
	Primary	8-hour	9,000	10,000	Annual second-highest value
Particulate matter (PM_{10})	Primary and Secondary	24-hour	NA	150	Not to be exceeded more than 3 times over 3 years
Particulate matter ($PM_{2.5}$)	Primary and Secondary	24-hour	NA	35	3-year average of the annual 98th percentile highest daily average concentrations
	Primary	Annual	NA	12	3-year average annual mean value
	Secondary	Annual	NA	15	3-year average annual mean value
Ozone	Primary and Secondary	8-hour	70[1]	137[1]	3-year average of the annual fourth-highest daily 8-hour concentrations
Lead	Primary and Secondary	3-month rolling	NA	0.15	Not to be exceeded

[1] Revised October 2015.

PM_{10} = particulate matter with an aerodynamic diameter of 10 microns or less.

$PM_{2.5}$ = particulate matter with an aerodynamic diameter of 2.5 microns or less.

ppbv = parts per billion by volume.

μg/m^3 = micrograms per cubic meter, based on standard conditions.

NA = Not Applicable.

Source: USEPA 2016. 40 Code of Federal Regulations (CFR) Part 50.

In ongoing review and regulatory actions, USEPA and the state and tribal governments designate areas as:

- “attainment,” or “better than national ambient air quality standards” if monitored data demonstrate compliance with the standards;
- “unclassifiable” or “cannot be classified” if monitored data are not available for such determinations; or
- “non-attainment” (specifically: “Does not meet primary standards” or “Does not meet secondary standards”) if monitored values of the criteria air pollutants are above the NAAQS.

Non-attainment areas for ozone also may be sub-classified from marginal to extreme” and non-attainment areas for PM_{10} and $PM_{2.5}$ may be sub-classified as moderate or serious depending on the air quality levels. In the 300-kilometer (km) area around NGS and the proposed KMC, all areas are designated as attainment or unclassified, therefore, the area is in compliance with the NAAQS. The air quality in the area around the transmission lines and communication sites would not be affected by the Proposed Action because only small and intermittent emissions are generated by the Proposed Action and action alternatives.

The NAAQS were established to provide ample protection of air quality, even for receptors that may be particularly sensitive to air quality conditions (also see Section 3.16) such as children, the elderly, and acutely or chronically ill persons with respiratory diseases. Sensitive receptor locations can include schools, day care facilities, hospitals, senior citizen centers, and recreational areas that are frequented by youth.

3.1.1.2 Hazardous Air Pollutants

Hazardous air pollutants (HAPs), as defined in Section 112(b) of the Clean Air Act, would be generated by some operations under the Proposed Action and action alternatives. **Table 3.1-2** provides selected regulated sources of HAPs that must comply with specific requirements as provided under the National Emission Standards for Hazardous Air Pollutants (40 CFR Part 63). There are numerous standards within this regulation that would not apply to the Proposed Action or alternative emission sources.

Table 3.1-2 Summary of Hazardous Air Pollutant Regulations

Regulation	Summary	How the Facility Complies
Hazardous Air Pollutants	Regulation of HAPs was expanded as part of Title III of the Clean Air Act in its 1990 amendments. The Clean Air Act identifies 186 chemicals or chemical groups as HAPs that may cause cancer or other serious effects on humans or adverse ecological effects. Diesel particulate matter and Diesel Exhaust Organic Gases also have been identified as carcinogenic HAPs (66 Federal Register 17235). There are no U.S. or Navajo National Environmental Protection Agency ambient air quality standards for HAPs, but emissions are controlled under various stationary and mobile source emissions standards. Some states have adopted separate sets of air quality levels for these and similar pollutants, but those standards do not apply to the Proposed Action. The Clean Air Act regulations include establishing national emission standards for HAPs for stationary sources under Title III of the Clean Air Act, with regulations promulgated in 40 CFR Parts 61 and 63. These regulations limit emission of HAPs from new and existing sources and apply to a wide range of specific source categories.	The implementing regulations in 40 CFR Part 63 include requirements for reciprocating internal combustion engines (Subpart ZZZZ). Two of the emergency generators at NGS are regulated under under Part 63.6590(b)(3)(iii) as existing emergency stationary reciprocating internal combustion engines, with a site rating of less than 500 brake horsepower, located at a major source of HAPs. Two auxiliary boilers also are regulated as existing oil-fired boilers under 40 CFR 63 Subpart DDDDD.
The Mercury and Air Toxics Standards Rule	The implementation of National Standards for HAPs includes a final regulation for HAP emissions from electric generating units (40 CFR 63 Subpart UUUUU), which applies to NGS. This regulation also is known as the Mercury and Air Toxics Standards Rule for power plants. It limits emissions of mercury acid gases, (hydrogen chloride or surrogate sulfur dioxide) and HAP metals (antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead, manganese, nickel, and selenium) which may be regulated as individual metals emissions, total metals emission, or total particulate matter emissions.	NGS has implemented the monitoring, testing, recordkeeping, and reporting requirements, and performed the applicable work practice standards that are mandated to demonstrate compliance with the Mercury and Air Toxics Standards Rule.

Source: USEPA 2015c.

The ambient concentrations and deposition rates of selected HAPs are key components of the evaluations related to the Ecological Risk Assessments (ERAs) that are reviewed in Sections 3.8 through 3.13 for vegetation, terrestrial wildlife, and aquatic biological resources, as well as the Human Health Risk Assessments (HHRAs) reviewed in Section 3.16.

3.1.1.3 Regional Haze

In the 1977 Amendments to the Clean Air Act, Congress added Section 169A to establish a national goal of the "prevention of any future, and the remedying of any existing, impairment of visibility in mandatory Class I Federal areas which impairment results from manmade air pollution." In 1980 USEPA promulgated regulations to address "reasonably attributable" visibility impairment in Class I national parks and wilderness due to a single source of small group of sources. Reasonably attributable visibility impairment has been certified for six coal-fired electric generating facilities since 1986. In March 1986 the Department of the Interior certified that Navajo Generating Station was causing visibility impairment in Grand Canyon National Park. After detailed technical analyses, public comment, and regulatory actions, emission controls to reduce sulfur dioxide were installed on the three NGS units between 1997 and 1999.

In the 1990 Amendments to the Clean Air Act, Congress added Section 169B to address regional haze, which is visibility impairment produced by multiple sources and activities across a broad geographic area. The Grand Canyon Visibility Transport Commission was created to recommend strategies to protect visual air quality at national parks and wilderness areas on the Colorado Plateau and made recommendations to USEPA in 1996.

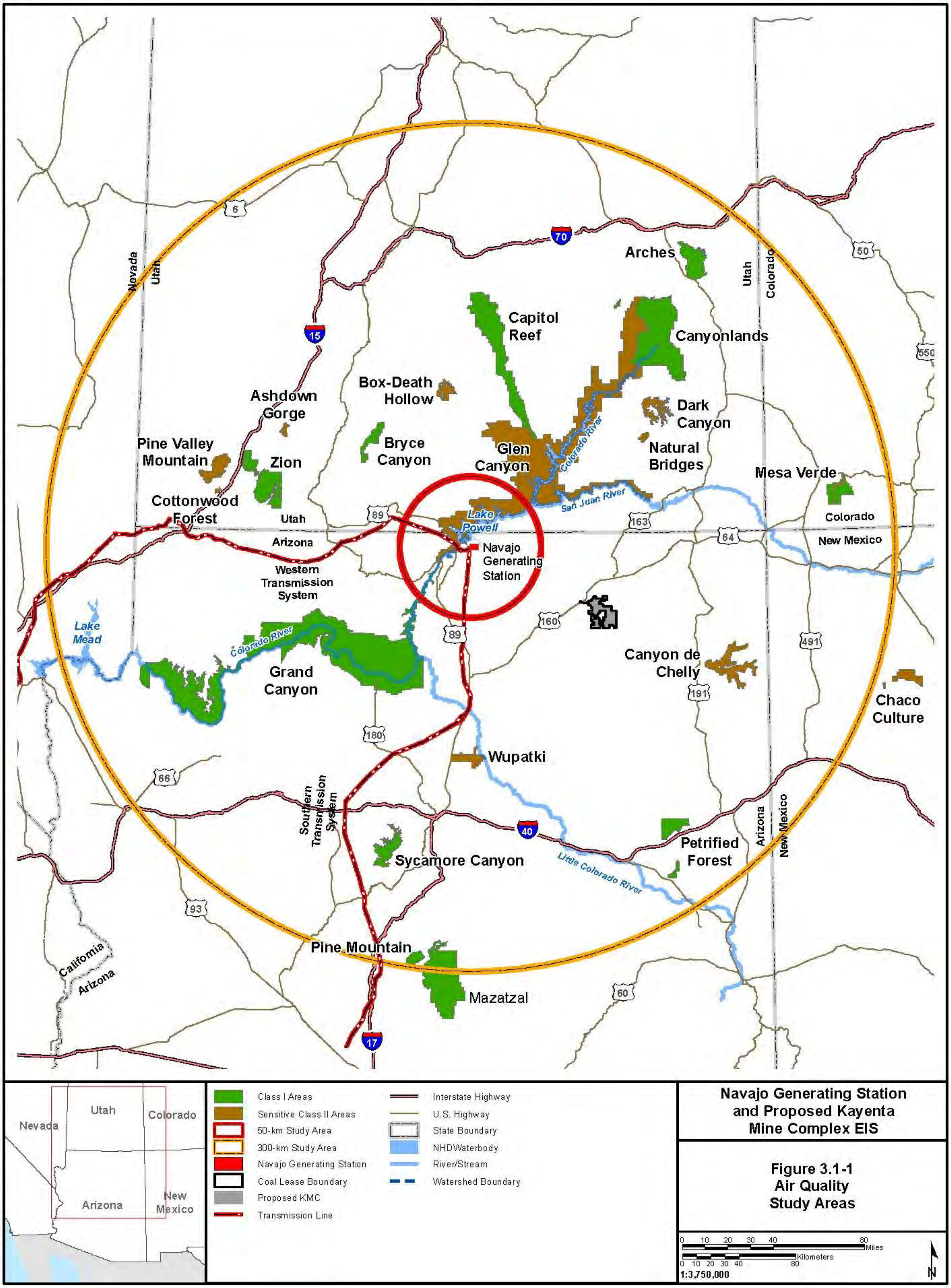
In 1999 USEPA promulgated the Regional Haze Rule that requires states or tribes to submit implementation plans every ten years that demonstrate long-term emission reduction strategies to improve visibility in Class I national parks and wilderness areas. In 2013 USEPA implemented a federal plan for NGS to meet the regional haze rule requirements to reduce visibility impacts of nitrogen oxides (USEPA 2013).

3.1.2 Study Areas

3.1.2.1 Proposed Action and Action Alternatives

The air quality study area is driven by the near- and far-field analysis distances of the employed guideline models (40 CFR Part 51 Appendix W provides a detailed description of model guidelines and limits of analyses). NGS is the major, regulated source of air emissions associated with the Proposed Action as emissions from tall stacks are dispersed over a broad area (Ramboll Environ 2016a). Therefore, the study area generally encompasses a 300-km distance from NGS (**Figure 3.1-1**). This distance also is used to evaluate impacts on Class I areas under the federal Prevention of Significant Deterioration regulations in 40 CFR Part 52.21. The study area does not extend beyond this distance, although the transmission lines and communication sites are located outside this study area. The emissions from the transmission line and communication site operations (e.g., truck and maintenance equipment use) would be intermittent and below any threshold that would trigger a review under air quality permitting requirements. Therefore, the study area does not specifically include these portions of the Proposed Action or alternatives.

A subset of the study area was used to assess NGS Near-field air quality and impacts through the use of the guideline AERMOD model, which is considered appropriate for a distance of 50 km from the modeled sources. That area includes distances up to 50 km from NGS, as reflected in **Figure 3.1-1**.



Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 3.1-1
Air Quality
Study Areas

A separate subset of the study area was used to assess air quality and impacts for the proposed KMC operations, which includes distances up to 50 km from the proposed KMC emission sources, as reflected in the dispersion modeling used to evaluate impacts associated with the proposed KMC mining activities (McVehil-Monnett Associates, Inc. [MMA] 2016).

3.1.2.2 Cumulative

The analysis of cumulative impacts within the study area also encompasses the broad 300-km study area and specifically includes the Class I and sensitive Class II areas within that area (**Figure 3.1-1**). The cumulative study area is the same as the study area for the Proposed Action. Given the nature of dispersion modeling and the necessity to have a large scale grid for photochemical modeling, some model results extend beyond that boundary; however, cumulative impacts were not evaluated beyond the 300-km distance.

3.1.3 Affected Environment

The affected environment analysis addresses the air quality emissions associated with existing facilities within the study area and the existing air quality conditions in the study area for NGS, the proposed KMC, and the transmission systems and communication sites.

3.1.3.1 Navajo Generating Station

NGS is located in a remote area, relatively distant from other major sources of air emissions. Although the impact from NGS emissions may reach to 300 km, impacts near the facility are dominated by NGS alone because there are no major sources (i.e., 100 tpy or more) within 50 km of NGS.

The USEPA develops a National Emissions Inventory for all listed sources in the U.S. every 3 years; the latest available set of such data is for 2011. **Table 3.1-3** lists data from the USEPA source inventory for 2011 for major sources (i.e., with emission of any pollutant above 100 tpy), for sources in southern Utah, northern Arizona, and the northwestern corner of New Mexico (San Juan County). **Figures 3.1-2a** through **3.1-2d** depict the location of these sources and the relative magnitude of the emission rates for oxides of nitrogen (NO_X), SO_2, PM_{10}, and $PM_{2.5}$, respectively. Representative names of these sources are included in the figures. Emissions impacts from other regional urban areas (Phoenix, Salt Lake City, Las Vegas) would be represented as background concentrations currently monitored at the regional air quality sites. The tabulated data are for 2011, and do not capture changes in air quality control since that time. NGS stands out as a relatively isolated emission source in these depictions.

3.1.3.1.1 Regional Air Quality

USEPA's Air Data Summary (USEPA 2014b) provides recent ambient air quality monitoring results at several sites in the region. The results are presented for sites in northern Arizona, Southern Utah, extreme northwestern New Mexico (San Juan County), and southwestern Colorado. There are no major industrial areas in the region; therefore, the ambient monitoring sites tend to be based in National Parks and in smaller local communities. The wide array of data from near Phoenix, Salt Lake City, and other distant and more populated areas is not representative of this region; therefore, it is not presented.

Table 3.1-4 provides a listing of the criteria pollutants, the regional monitoring site locations, and the applicable regulatory design value used to compare to the ambient standards. **Figure 3.1-3** depicts the locations of the sites referenced in **Table 3.1-4**. Criteria air pollutants SO_2, PM_{10}, and $PM_{2.5}$ were monitored near Page, Arizona. The data recorded near Page (Glen Canyon) were used for modeling near-field impacts to assess the environmental consequences of the proposed extension of NGS operations.

Table 3.1-3 Existing Major Sources and Pollutant Emissions in the Study Area

Facility	Pollutant Concentration (tpy)					Latitude	Longitude
	NO_X	SO_2	PM_{10}	$PM_{2.5}$	VOC		
Arizona Public Service Company - Cholla Power Plant	10,995	6,738	378	361	-	34.940	-110.300
Ash Grove Cement Company: Leamington Cement Plant	1,729	-	-	-	-	39.562	-112.196
Catalyst Paper (Snowflake) Inc.	2,184	2,896	133	110	-	34.504	-110.336
Chemical Lime Nelson Plant	1,103	1,995	300	-	-	35.518	-113.314
Coronado Generating Plant	9,017	7,352	768	594	-	34.578	-109.272
El Paso Natural Gas - Mojave Topock Compressor Station	118	-	-	-	-	34.727	-114.463
El Paso Natural Gas - Williams Compressor Station	915	-	-	-	-	35.311	-112.066
ETC Canyon Pipeline, LLC: San Arroyo Plant	192	-	-	-	-	39.398	-109.124
Four Corners Power Plant	38,729	11,822	3,117	1,859	15	36.689	-108.480
Genpak Corporation: Polystyrene Foam Production Facility	-	-	-	-	107	37.682	-113.100
Graymont Western Us Incorporated: Cricket Mountain Plant	1,065	-	225	121	-	38.939	-112.817
Intermountain Power Service Corporation: Intermountain Generation Station	25,296	4,937	1,703	1,398	-	39.504	-112.581
Lynndyl, Utah	194	-	-	-	-	39.518	-112.380
Navajo Generating Station	19,840	4,643	4,108	2,833	31	36.904	-111.389
Novo Biopower, LLC	212	-	-	-	-	34.504	-110.336
Pacificorp: Carbon Power Plant	3,665	7,740	633	532	-	39.727	-110.864
Pacificorp: Hunter Power Plant	13,720	4,662	595	349	117	39.173	-111.029
Pacificorp: Huntington Power Plant	6,192	2,531	428	121	-	39.379	-111.080
Patara Midstream, LLC: Lisbon Natural Gas Processing Plant	157	-	-	-	-	38.163	-109.276
Phoenix Cement – Clarkdale, Arizona	716	-	-	-	-	34.780	-112.084
San Juan Generating Station	17,104	4,741	496	438	192	36.802	-108.439
Sunnyside Cogeneration Associates: Sunnyside Cogeneration Facility	421	545	-	-	-	39.548	-110.383
Tucson Electric Power Company - Springerville	6,859	6,050	2,913	2,104	211	34.319	-109.164
Winslow, Arizona	256	-	-	-	-	35.029	-110.716

VOC = volatile organic compound.

Source: USEPA 2014a.

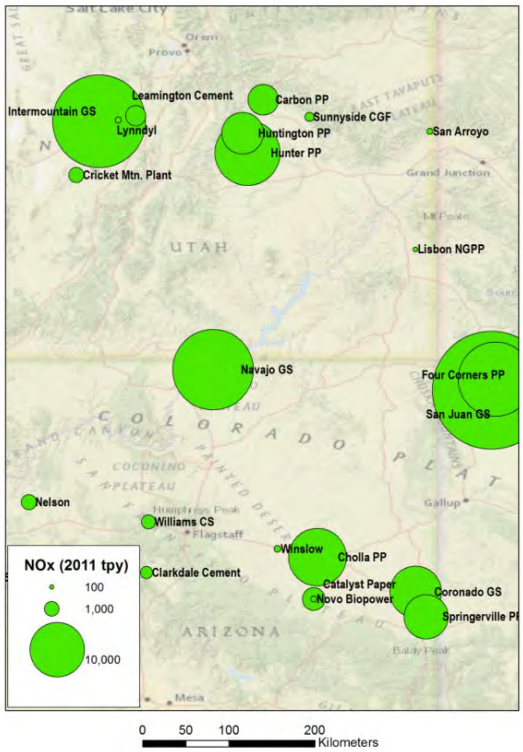


Figure 3.1-2a NO_X

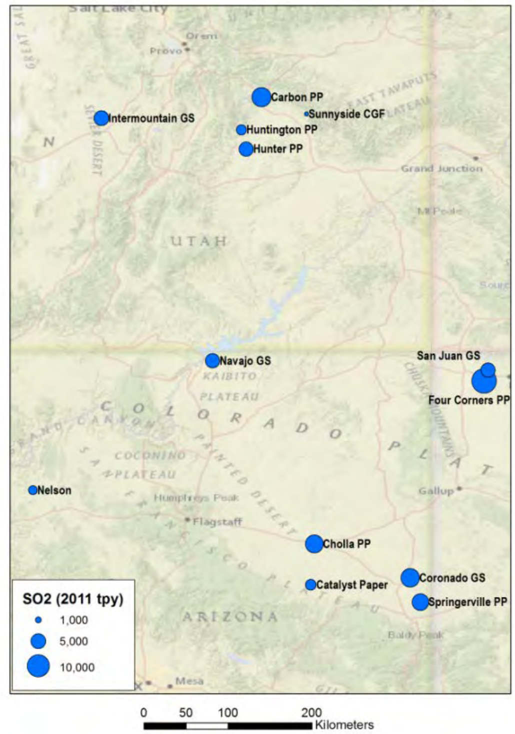


Figure 3.1-2b SO_2

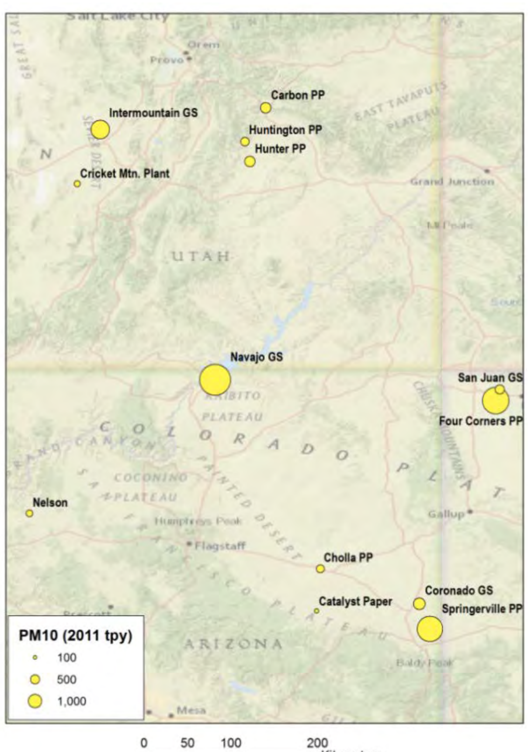
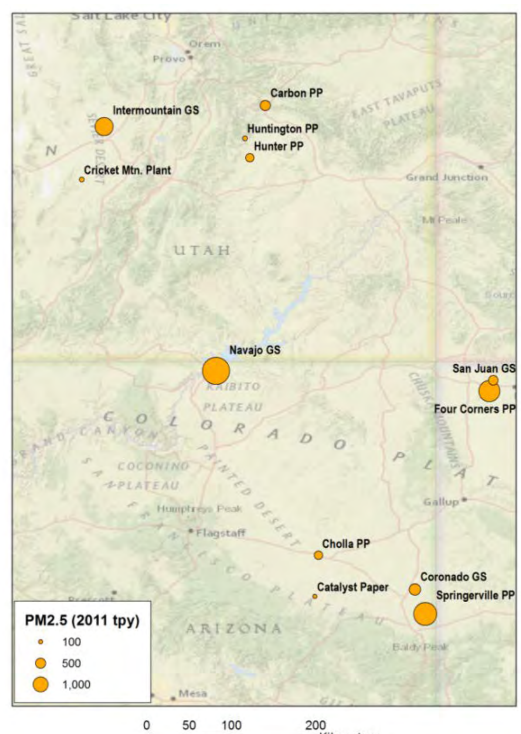


Figure 3.1-2c PM_{10}



Source: USEPA 2014a.

Figure 3.1-2d $PM_{2.5}$

Figure 3.1-2a-d Nearest Major Sources of Criteria Air Pollutants for NO_X, SO_2, PM_{10}, and $PM_{2.5}$

Table 3.1-4 Monitored Air Quality Conditions in the NGS-KMC Region

Pollutant	Site Location	2011	2012	2013 (3-yr avg)	2014 (3-yr avg)	Standard
NO_2 Annual Average (ppb)	Shiprock, NM	8.8	5.6	8.0	4.7	53 ppb
	Hurricane, UT [1]	9.3	9.2	10.1	9.4	
NO_2 8th Highest Hourly Daily Maximum (ppb)	Shiprock, NM	36	37	38	32	100 ppb (3-year average)
	Hurricane, UT	19 [2]	22	28	24	
CO 2nd Highest Hourly (ppm)	Ignacio, CO	1.3	0.8	1.7	1.3	35 ppm
CO 2nd Highest 8-hour (ppm)	Ignacio, CO	0.7	0.6	1.0	1.0	9 ppm
SO_2 99th Percentile Highest Hourly Daily Maximum (ppb)	Farmington, NM	20	24	25	14	75 ppb (3-year average)
	Bloomfield, NM	9	9	8	5	
	Page/Glen Canyon, AZ	9	10	7	8	
SO_2 2nd Highest 24-hour (ppb) [3]	Farmington, NM	3	4	3	2	140 ppb
	Bloomfield, NM	2	3	3	2	
PM_{10} 2nd Highest Daily (24-hour) Average (μg/m³)	Flagstaff, AZ	37	35	27	--	150 μg/m³
	Tuba City, AZ	48	50	--	--	
	McNary, AZ	59	56	54	48	
	Whiteriver, AZ	44	53	46	47	
	Page/Glen Canyon, AZ	15	23	49	33	
$PM_{2.5}$ 98th Percentile Highest Daily (24-hour) Average (μg/m³)	Fort Defiance, AZ	12	10	--	--	35 μg/m³ (3-year average)
	Flagstaff, AZ	14	12	10	--	
	Peach Springs, AZ	5	11	14	10	
	Zion NP/Hurricane, UT	12	12	12	9	
	Page/Glen Canyon, AZ	7	9	43	23	
	Farmington, NM	12	11	16	8	
$PM_{2.5}$ Annual Average (μg/m³)	Fort Defiance, AZ	3.6	2.8	--		12 μg/m³
	Flagstaff, AZ	5.2	5.4	5.4		
	Peach Springs, AZ	2.9	3.8	3.9	3.2	
	Zion National Park/Hurricane, UT	4.6	6.6	6.3	4.0	
	Page/Glen Canyon, AZ	2.1	3.2	11.5	6.2	
	Farmington, NM	4.1	4.9	5.0	3.7	
Ozone 4th Highest 8-hour Daily Maximum (ppb)	Flagstaff, AZ	68	72	69 (69)	73 (71)	70 ppb (3-year average) 75 ppb during 2011 to 2014
	Grand Canyon, AZ	74	73	69 (72)	69 (70)	
	Petrified Forest, AZ	69	73	69 (70)	68 (70)	
	Escalante National Monument, UT	-	68	67 (67)	60 (65)	
	Canyonlands National Park, UT	69	72	66 (69)	67 (68)	
	Hurricane, UT	68	59	69 (65)	70 (66)	
	Zion National Park, UT	72	75	70 (72)	69 (71)	
	Average	70.0	70.3	68.4	68.0	

[1] In Santa Clara Utah, near Hurricane

[2] Average for available monitored data in Washington County, Utah.

[3] Only 24-hour data reported for this site.

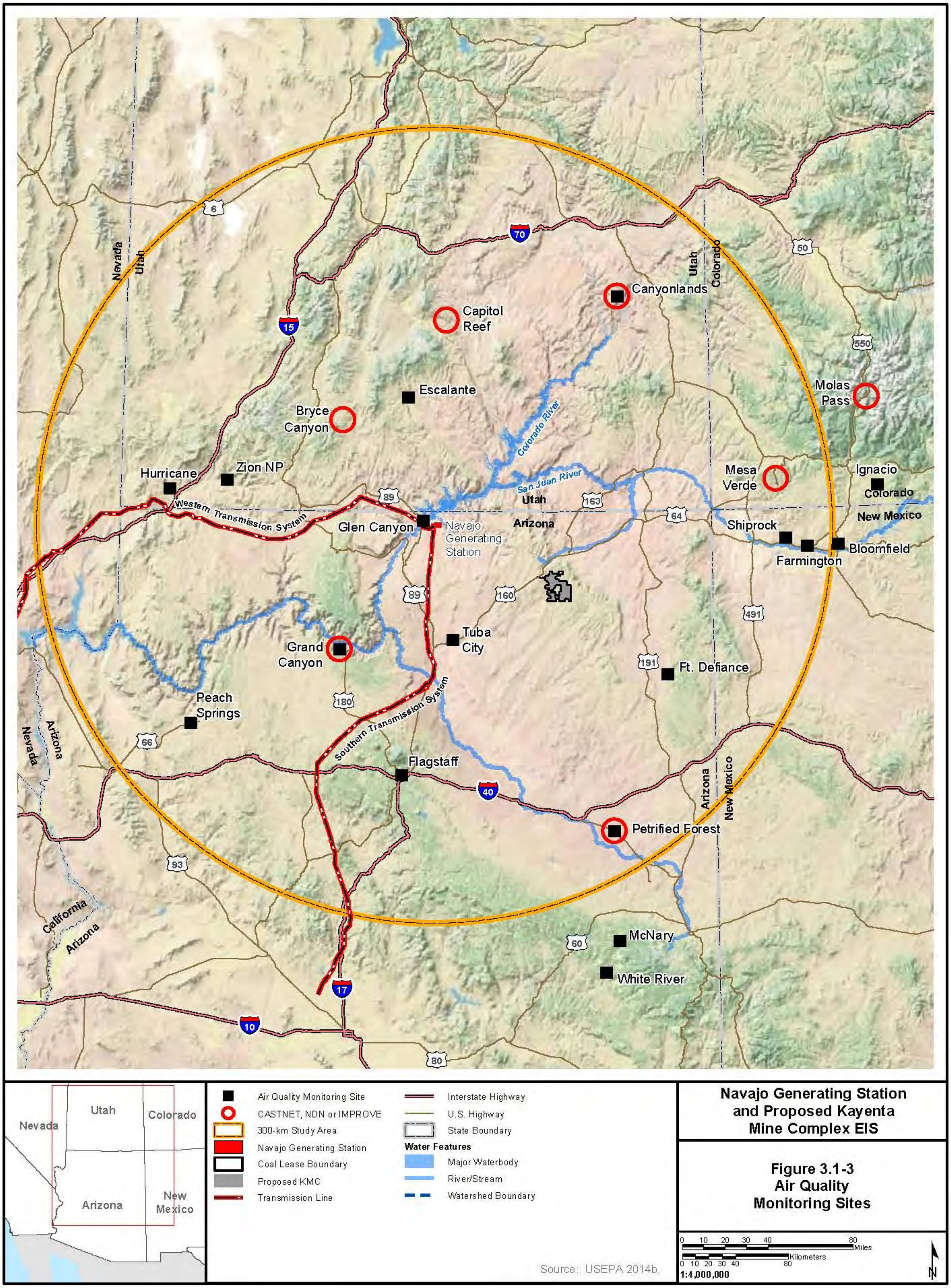
NP = National Park.

ppb = parts per billion.

ppm = parts per million.

μg/m³ = micrograms per cubic meter.

Source: USEPA 2014b (for all air quality data except Page, Arizona).



Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 3.1-3 Air Quality Monitoring Sites

Representative data on SO_2 monitoring sites are limited; **Table 3.1-4** includes two locations in northwestern New Mexico as being the nearest sites. Data for carbon monoxide generally are collected in urban areas. For this analysis, the data recorded near Ignacio, a small community in La Plata County, Colorado, may be the most representative regional data. All monitored levels are well below the NAAQS.

Ozone data show considerable variability among the stations, with a general year-to-year consistency among the stations (e.g., 2012 was relatively higher and 2013 was relatively lower). Overall the seven station average of the annual 4th highest levels decreases from 70 ppb in 2011 to 68 ppb in 2014. Two data points could not be used to generate a statistical trend; however, the average levels point to a potential reduction in regional ozone levels. The 3-year averages for ozone provide a comparison to the 3-year design value concentration. The 8-hour ozone standard was 75 ppb during the 2011-2014 time period, but was revised to 70 ppb in October 2015 (80 Federal Register 65452).

Regional NO_2 data also show some year-to-year variability, but no clear trend in either the annual average levels or in the 8th highest of the annual daily 1-hour maximum levels. The data demonstrate that the regional air quality conditions are well below the NAAQS.

The PM_{10} data show 24-hour levels (2nd highest annual daily average) that are approximately 33 percent of the ambient standard. The $PM_{2.5}$ data also show interannual variability with no clear trend.

3.1.3.1.2 Visibility and Regional Haze

Visibility is a critical resource value in this region, particularly at the regional Class I areas (Colorado State University 2014a). Aerosols in the atmosphere scatter and absorb light. Multiple pollutant species contribute to total light extinction as measured at the IMPROVE monitors. Fossil fuel combustion is a major contributor to ammonium sulfate and ammonium nitrate aerosols, while wildland fires are major contributors to organic carbon and elemental carbon. These data represent a calculated value applied to the total atmospheric aerosol extinction (Colorado State University 1993) on a logarithmic scale that is intended to represent human perception of regional haze. Pristine conditions would be represented with a deciview value of zero. Deciview is a measurement of visibility impairment, and is a haze index calculated from light extinction. The deciview is expressed in terms of extinction coefficient (b_{ext}) and visual range (vr): haziness (dv) = 10 ln (b_{ext}/0.01 km-1) = 10 ln (391 km/vr). A change in deciviews of 1 would represent a small but noticeable change in haziness under most circumstances when viewing scenes in Class I areas (Colorado State University 1993).

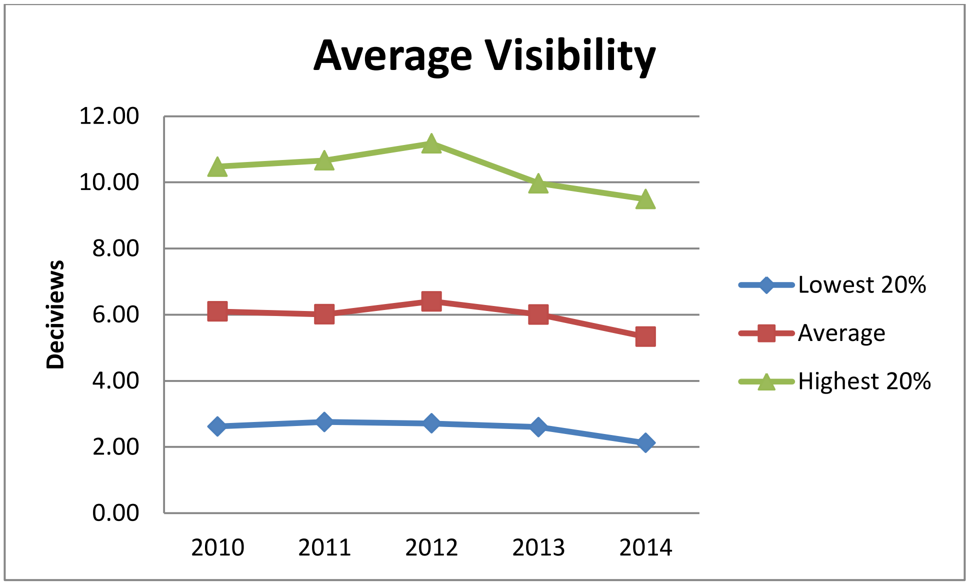
Table 3.1-5 depicts the average deciviews measured at the six indicated sites in the IMPROVE (Interagency Monitoring of Protected Visual Environments) Network. The IMPROVE program was initiated in 1985 to establish current visibility conditions and trends in National Parks and Wilderness Areas. **Table 3.1-5** provides data for the 20 percent least hazy (the lowest deciview levels) days, the average day, and the 20 percent haziest days (highest deciview levels) for the period from 2010 to 2013. These data were used to estimate a baseline regional haze level at the indicated sites through 2019.

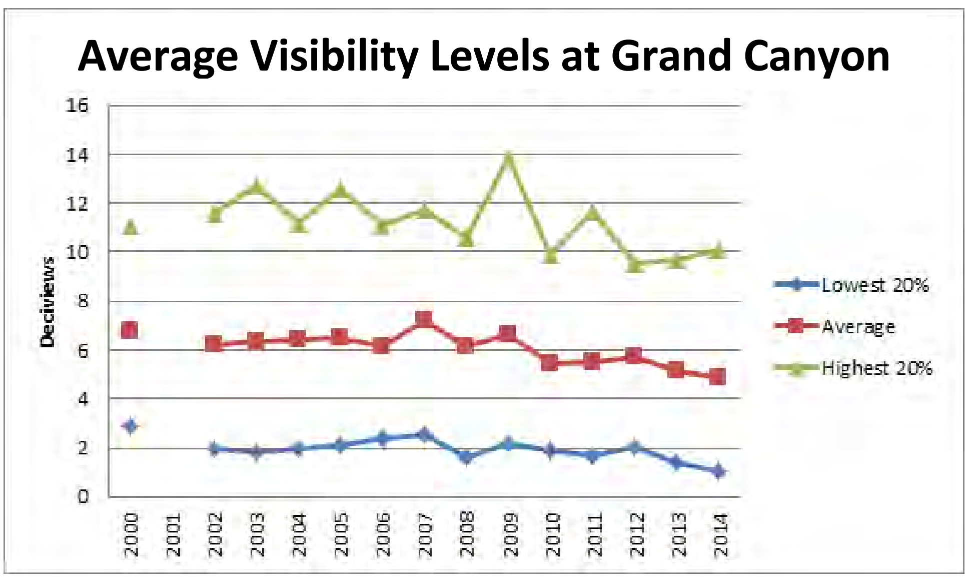
As with air quality conditions, there is notable variability in the data from year to year, but no clear trend at any of the sites or in any of the levels of haziness. The average of these three levels at the six sites are shown in **Figure 3.1-4** and indicate no clear trend; although, 2013 was slightly less hazy overall than the preceding 3 years. **Figure 3.1-4** also provides the haze levels at the Grand Canyon for 2000 through 2014 to provide a longer term perspective. The location of these Class I areas is depicted in **Figure 3.1-1**.

Table 3.1-5 Visibility (Haziness) Records at IMPROVE Sites

Parameter	Site	Visibility by Year (deciviews)				
		2010	2011	2012	2013	2014
Lowest 20% of Days (least hazy)	Bryce Canyon	1.66	2.00	1.67	1.40	1.16
	Canyonlands	2.74	2.74	3.20	3.37	2.60
	Capitol Reef	2.15	2.89	2.41	2.93	2.12
	Mesa Verde	3.03	3.18	2.73	2.91	2.44
	Grand Canyon	1.87	1.70	2.05	1.37	1.05
	Petrified Forest	4.27	4.03	4.24	3.63	3.37
Average of All Days	Bryce Canyon	5.55	5.28	5.80	5.51	4.89
	Canyonlands	5.78	5.73	6.27	6.32	5.37
	Capitol Reef	5.90	5.83	6.36	6.21	5.38
	Mesa Verde	6.41	6.25	6.42	6.32	5.14
	Grand Canyon	5.43	5.48	5.73	5.13	4.89
	Petrified Forest	7.51	7.51	7.84	6.55	6.36
Highest 20% of Days (haziest)	Bryce Canyon	9.39	10.77	10.46	9.16	8.49
	Canyonlands	10.70	9.91	11.61	10.40	9.14
	Capitol Reef	9.63	9.29	11.79	9.94	9.14
	Mesa Verde	11.78	10.47	11.57	10.58	9.52
	Grand Canyon	9.87	11.65	9.55	9.68	10.10
	Petrified Forest	11.49	11.90	12.10	10.07	10.56
Average	Lowest 20%	2.62	2.76	2.72	2.60	2.12
	Average	6.10	6.01	6.40	6.01	5.34
	Highest 20%	10.48	10.66	11.18	9.97	9.49

Source: Colorado State University 2016.





Source: CSU 2016.

Figure 3.1-4 Average Visibility Levels

3.1.3.1.3 Atmospheric Deposition

Natural ecosystems are affected by deposition of acidic compounds from the atmosphere to the soil, water, and living plant tissue. Acid deposition can have harmful effects on plants, aquatic animals, and infrastructure. Precursors include emissions of SO_2 and NO_X that can react with water molecules in the atmosphere to produce acids, which are deposited during rainfall events (i.e., wet deposition) or the settling of acid particles on the plant, waterbodies, and soil receptors (i.e., dry deposition). Existing data, including averages and annual trends in deposition, are provided for the monitored sites to depict the background setting. These data were used for comparison to the environmental consequences of the Proposed Action and action alternatives.

The Clean Air Status and Trends Network is a long-term environmental monitoring network throughout the U.S. and Canada designed to provide data to assess trends in air quality, atmospheric deposition, and ecological effects due to changes in air pollutant emissions. Data primarily are collected at National Parks, but other sites were added in 2012. The data are provided for 85 sites across the U.S., including four National Parks in the region of the Proposed Action (Canyonlands, Grand Canyon, Petrified Forest, and Mesa Verde). **Table 3.1-6** provides the overall average of dry deposition and wet deposition (collected from precipitation events) of nitrogen and sulfur compounds. Dry nitrogen deposition includes chemical species of nitrates and nitric acid, and dry deposition of sulfur includes chemical species of SO_2 and sulfates. The trend in deposition rates was calculated using a least-squares linear fit to the available data for 1990-2013. Individual yearly data for each site are provided in **Appendix 3.1-A**, **Tables 3.1-A.1** through **3.1-A.4**.

Table 3.1-6 Average and Trends in Atmospheric Deposition at Clean Air Status and Trends Network Sites (1990 to 2013)

	Average Deposition (kg/ha-year)				Trend (kg/ha-year per year)			
	Nitrogen		Sulfur		Nitrogen		Sulfur	
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
National Park Sites	(NO_3)	(NO_3 + HNO_3)	(SO_4)	(SO_2 + SO_4)	(NO_3)	(NO_3 + HNO_3)	(SO_4)	(SO_2 + SO_4)
Canyonlands	1.16	0.89	0.60	0.22	-0.023	-0.023	-0.026	-0.008
Grand Canyon	1.21	0.82	0.60	0.21	0.015	-0.014	-0.008	-0.006
Petrified Forest	1.02	1.15	0.66	0.50	0.011	-0.050	-0.018	-0.041
Mesa Verde	1.46	0.97	1.07	0.28	-0.005	-0.014	-0.042	-0.014
Average	1.21	0.96	0.73	0.30	-0.001	-0.025	-0.024	-0.017

kg/ha = kilogram per hectare.

HNO_3 = nitric acid.

SO_2 = sulfur dioxide

SO_4 = sulfate.

NO_3 = nitrate.

Source: USEPA 2015a.

The National Deposition Network was formed by the U.S. State Agricultural Experiment Stations in 1977 and continually has added networks and stations since that time. The National Deposition Network collects data at 250 sites across the U.S. and represents a cooperative arrangement among federal, state, tribal, and local government agencies; educational institutions; private companies; and non-governmental organizations. In the NGS region, data have been collected at six sites used to depict the existing environment. These include the Grand Canyon National Park, Petrified Forest National Park, Mesa Verde National Park, Canyonlands National Park, Bryce Canyon National Park, and a site on Molas Pass, Colorado. Although data are collected by the Clean Air Status and Trends Network program in some similar locations, the results are affected by the representativeness of the particular site as well as the region. The National Deposition Network collects only wet deposition data. The annual average deposition rates of nitrogen compounds, sulfur compounds, and ammonia are provided in **Table 3.1-7** for the latest 5 years of data (2010 to 2014) (see **Appendix 3.1-B** for details). The shaded cells show the maximum deposition rate among the six sites for that year.

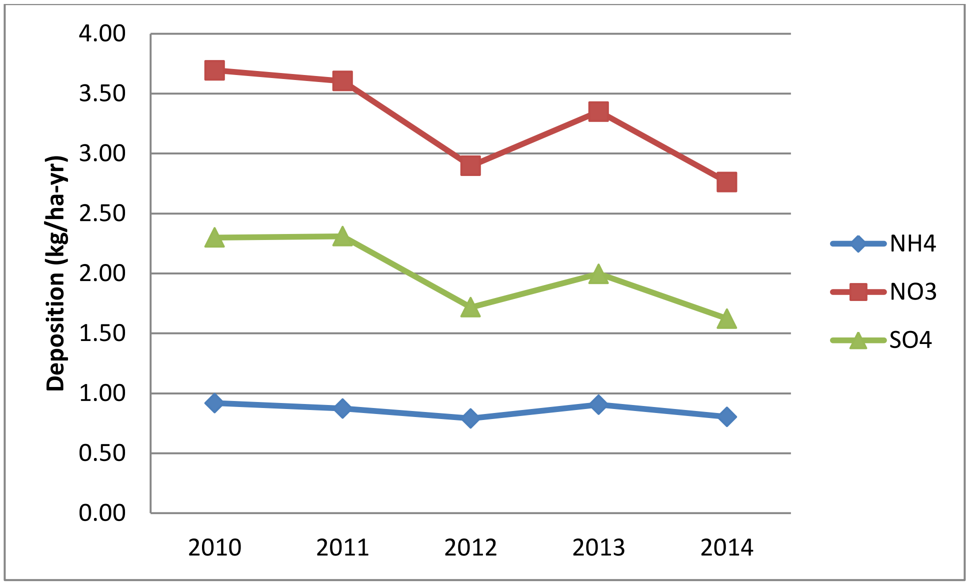
Table 3.1-7 Annual Average Deposition Rates At National Deposition Network Sites

Parameter	Site	Annual Average Deposition (kg/ha-year)				
		2010	2011	2012	2013	2014
Ammonium	Grand Canyon NP	1.91	0.7	0.9	0.92	0.69
	Petrified Forest NP	0.9	1.02	0.81	0.55	0.46
	Molas Pass, CO	0.68	0.9	0.99	0.92	1
	Mesa Verde NP	0.91	1	0.76	1.32	1.16
	Canyonlands NP	0.56	0.78	0.46	0.6	0.82
	Bryce Canyon NP	0.55	0.84	0.82	1.12	0.69
Nitrate	Grand Canyon NP	6.42	2.54	3.02	2.94	2.3
	Petrified Forest NP	2.65	3.7	2.48	1.64	1.24
	Molas Pass, CO	4.2	4.97	3.94	4.72	4.31
	Mesa Verde NP	4.5	4.89	3.5	5.27	4.39
	Canyonlands NP	2.45	2.5	1.62	1.95	2.13
	Bryce Canyon NP	1.94	3.03	2.82	3.58	2.2
Sulfate	Grand Canyon NP	3.58	1.54	1.32	1.38	0.97
	Petrified Forest NP	1.83	2.25	1.49	0.85	0.82
	Molas Pass, CO	1.97	2.53	1.84	2.46	2.23
	Mesa Verde NP	2.51	2.95	2.21	2.92	2.28
	Canyonlands NP	1.11	1.64	0.8	1.1	1.16
	Bryce Canyon NP	1.4	1.65	1.47	1.91	1.14
Averages	Ammonium	0.92	0.87	0.79	0.91	0.80
	Nitrate	3.69	3.61	2.90	3.35	2.76
	Sulfate	2.30	2.31	1.72	2.00	1.62

NP = National Park.

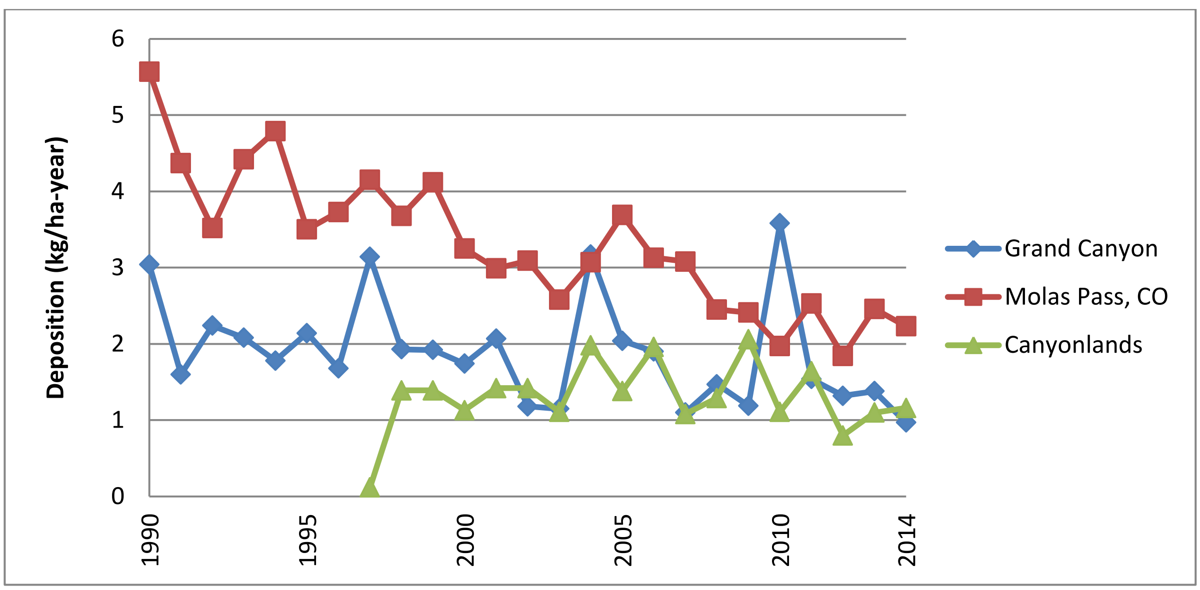
Source: National Atmospheric Deposition Program 2015a.

The National Deposition Network collects other deposition data as well, but those compounds are not relevant to the emissions from the Proposed Action. Ammonia levels are included because ammonia plays a role in enhancing the formation of sulfates and nitrates in the atmosphere, which ultimately are included in the condensable portion of $PM_{2.5}$. **Figure 3.1-5** provides the average deposition rate for ammonia, nitrates, and sulfates at the six sites noted above. It shows an overall reduction in these rates, particularly for nitrates and sulfates. Longer term data are available for three of those sites as shown in **Figure 3.1-6**. Wet sulfate deposition at Molas Pass, Colorado has shown a fairly consistent downward trend since 1990. The peak deposition at Grand Canyon National Park for 2010, which was seen in the Clean Air Status and Trends Network data, also is evident in this figure (see **Appendix 3.1-A** for details). The individual yearly peaks are part of the inter-annual variability in deposition that can occur at any one site in the region.



Source: USEPA 2015.

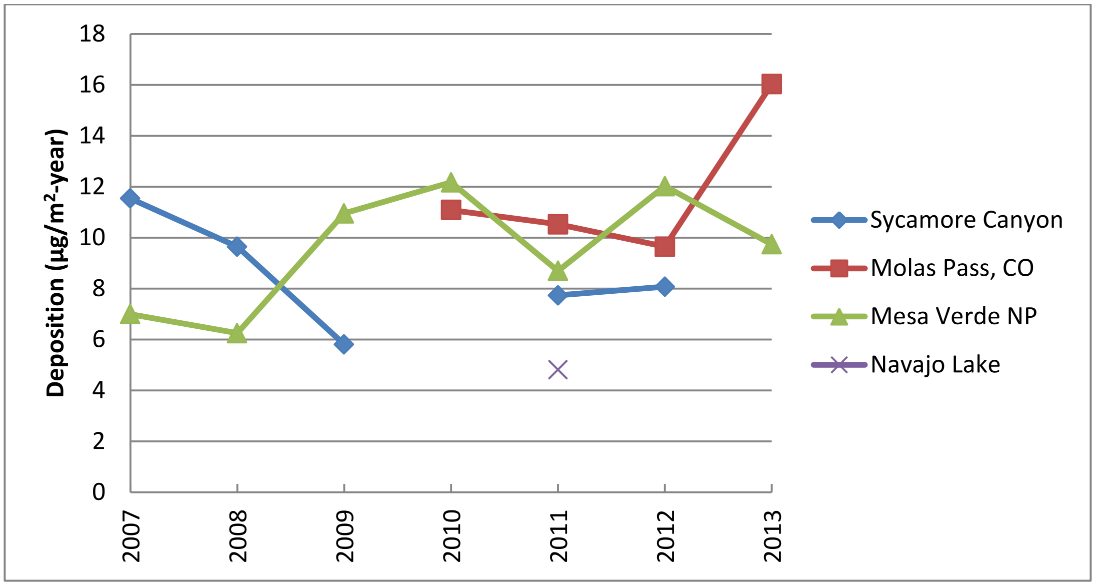
Figure 3.1-5 Average Total Annual Wet Deposition Rate at Six National Deposition Network Sites



Source: National Atmospheric Deposition Program 2015a.

Figure 3.1-6 Annual Wet Sulfate Deposition at Three National Deposition Network Sites

The National Deposition Network also started operating a Mercury Deposition Network in 1996 and currently collects data at over 100 sites in the U.S. and Canada. The collected data represent mercury deposition in precipitation events but not dry deposition. Available data for four sites in the region are provided in **Figure 3.1-7**. While the record is of a fairly short duration, the record for Mesa Verde extends from 2002 and provides the longest term continual representation of mercury (wet) deposition.



Source: Mercury Deposition Network 2015.

Figure 3.1-7 Annual Total Mercury Wet Deposition at Mercury Deposition Network Sites

Except for mercury deposition, the overall air quality conditions and air quality-related values in the region generally are improving or being maintained. Part of the improvement in these conditions may be attributed to improved emission controls on the region's power plants and on general improvements in emission from minor sources and motor vehicles.

3.1.3.2 Proposed Kayenta Mine Complex

The proposed KMC is within the 300-km study area. It is part of an active coal mine that has been in operation for 40 years. The Proposed Action incorporates land and facilities from the adjacent former Black Mea Mine without authorizing any further mining on those lands. Mining operations include extensive excavation and handling of overburden, excavation and handling of coal, and off-road mining equipment that generates emissions from fuel combustion and from fugitive dust. Air quality conditions are provided to depict the existing conditions at the residences located within the mine lease area boundary, as well as receptors that are on and beyond that boundary.

Peabody Western Coal Company collects ambient air quality data at the proposed KMC using monitors and samplers located on the mine lease area. The data show that ambient air quality conditions meet the NAAQS or the level of the standard (where less than 3 years' data have been collected, because compliance with some standards are based on 3 years of data). The data address conditions within the mine lease area because human residences occur within that area, and the monitoring is partially aimed at capturing the representative impacts on air quality for those residences. As a result, the proposed KMC data represent the critical air quality conditions in the affected environment in this study area. **Figure 3.1-8** depicts the identified resident receptors within and outside the proposed KMC permit boundary. The existing air quality conditions at the proposed KMC can be used to characterize the air quality at these receptor locations. Dispersion modeling was conducted that specifically addressed air quality impacts at those receptors. The available data are summarized in **Table 3.1-8**. SO_2 and CO are not monitored at this facility because there are no major sources of these pollutants. Carbon monoxide essentially is an urban pollutant related to high volumes of vehicular traffic.

Table 3.1-8 Monitored Air Quality Conditions at the Proposed KMC

Parameter	Site Location	2011	2012	2013	2014	Standard
NO_2 Annual Average (ppb)	N9[1,2] J21[3]		2.2	3.2 2.4		53 ppb
NO_2 8^{th} Highest Hourly Daily Maximum (ppb)	N9 J21		39	36 35		100 ppb (3-year average)
PM_{10} 2^{nd} Highest Daily 24-hour) Average[4] ($\mu g/m^3$)	AIRQ1 AIRQ2R AIRQ3R AIRQ4R AIRQ5R AIRQ6R AIRQ7R AIRQ8R AIRQ12 AIRQ200 AIRQ201 AIRQ202	31.1 42.4 66.0 41.5 49.9 32.9 40.5 67.2 52.7 33.7 47.2 32.6	55.8 62.3 109.7 39.5 37.7 34.1 26.1 55.2 67.8 28.2 47.2 53.5	36.7 53.1 80.8 83.8 80.4 37.7 34.8 56.1 97.1 32.2 72.0 54.4		150 $\mu g/m^3$
$PM_{2.5}$ 98^{th} Percentile Highest Daily (24-hour) Average[5] ($\mu g/m^3$)	AIRQ1 AIRQ3R AIRQ6R				10 10 8	35 $\mu g/m^3$ (3-year average)
$PM_{2.5}$ Annual Average[5] ($\mu g/m^3$)	AIRQ1 AIRQ3R AIRQ6R				4.4 4.3 3.2	12 $\mu g/m^3$
Ozone 4^{th} Highest 8-hour Daily Maximum (ppb)	N9[1,2]		70	66		75 ppb pre-2014, 70 ppb in 2014 (3-year average)

[1] Data collection began 08/01/2011.

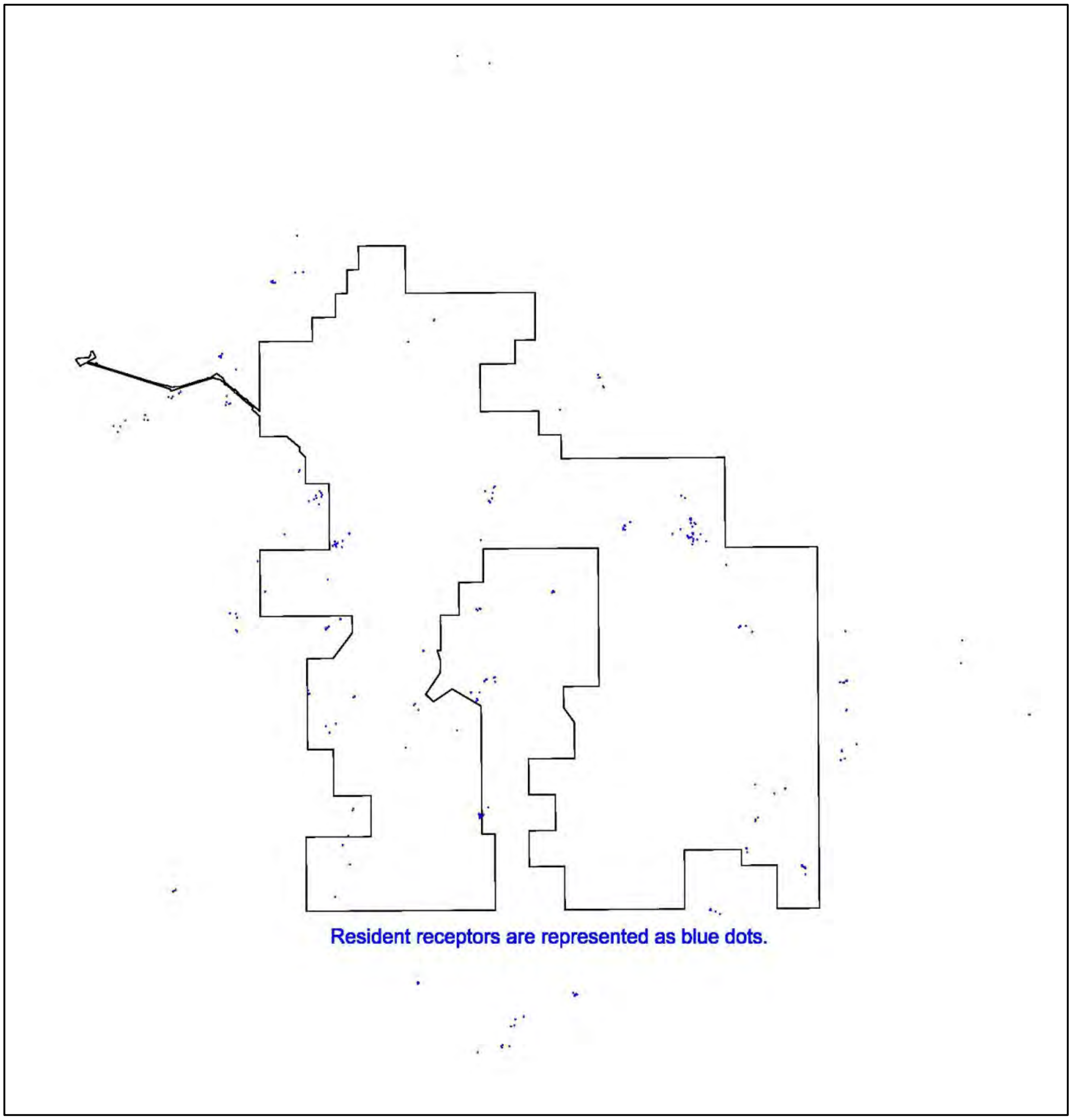
[2] Background data for 3-year monitoring period ended 07/31/2014.

[3] Valid data began on 02/01/2012.

[4] PM_{10} background 3-year monitoring period 01/01/2011 through 12/31/2013.

[5] $PM_{2.5}$ data collection began 10/01/2013.

Source: Lehn 2015.



Source: MMA 2016.

Figure 3.1-8 Residence Receptors at Proposed KMC

All ambient air quality data collected for this region, including the sites referenced above, indicate ambient levels well below the standards. A series of separate annual reports provides details of the data collection activities, monitoring results, and review of quality control and quality assurance activities for the monitoring program (**Appendix 3.1-C**).

3.1.3.3 Transmission Systems and Communication Sites

The existing transmission lines and communication sites operate at remote locations from NGS and the proposed KMC. The communication sites include propane-fired generators to provide backup emergency power. Many of the sites are operated and maintained by other users. Maintenance activities for the communication sites, transmission systems, and access roads can include vehicle traffic (vehicle exhaust and fugitive dust from unpaved roads), but the maintenance activities typically are infrequent, of short duration, and/or localized (**Appendix 1B**). For example, transmission line structure maintenance and repair occur on an as-needed basis; routine actions such as vegetation clearing occurs once every 5 years, or less frequently depending on need; repair of access roads and transmission tower infrastructure occurs along localized sections of the lines or roads as needed; and maintenance of access roads occurs once or twice a year, but equipment moves through the areas quickly.

3.1.4 Environmental Consequences

3.1.4.1 Issues

Air quality related issues center around demonstrating compliance with the existing, and applicable, NAAQS. In addition, data are provided for use in other resource reports related to climate change, deposition, human health, and ecological risk assessment. Specific air quality data and analyses characterized in capturing the environmental issues of the Proposed Action and action alternatives include in the following:

- Emissions from facility operations, considering equipment design, hours of operation, operational limits, control technologies, and any alternate scenarios. This task included identifying all relevant sources of emissions for each source, source grouping, or operation.
- Impacts on ambient air quality, determined through atmospheric dispersion modeling of the Proposed Action and action alternatives based on guideline technical analyses.
- Maximum impacts and spatial extent of impacts from the Proposed Action and action alternatives emissions compared to ambient air quality standards, including ozone levels.
- Extent of impacts from acid deposition and plume or visibility impacts at sensitive areas.

3.1.4.2 Assumptions and Impact Methodology

The estimation of environmental consequences requires analysis of air emissions, including emissions controls, and impacts on air quality conditions both locally and within the study area. The various emission assumptions and controls on operations at NGS are provided in **Table 3.1-9**.

Table 3.1-9 Key Assumptions Regarding Emissions Calculations at NGS

Operation or Source	Key Emissions Assumptions
Electric Generating Units Coal- and Oil-fired	Fuel feed rate, electrostatic precipitator and flue gas desulfurization Control Efficiency, Density of Fuel
Water Cooling Towers	Total dissolved solids, circulation rate, percent of solids not deposited on site, drift loss percent
Auxiliary Boilers	Fuel feed rate, density of fuel, approved factors for estimating emissions (e.g., USEPA AP-42)
Coal Handling and Storage (no coal pile)	Handling operations activity, approved factors for estimating emissions (e.g., USEPA AP-42), controls
Coal Storage Piles	Handling operations activity, USEPA AP-42 factors based on aggregate handling equation, controls
Limestone Handling and Storage	Limestone handling throughput, USEPA AP-42 factors, controls
Limestone Handling and Storage - Dust Collectors	Grain loading, average flow rate
Fly Ash Handling (no Disposal Site)	Fly ash bins, wetted bottom ash, transfers, baghouses
Fly Ash Handling - Disposal Site Materials Handling	Calculation of emissions at land fill, disposal and fugitive emission area
Soda Ash/Lime Handling	Handling operations activity, emission factors from USEPA AP-42 source-specific tables, or factors in USEPA AP-42 drop equation, controls
Fugitives - Mobile	Vehicle weights, controls, vehicle miles traveled, percentage onsite/offsite and paved/unpaved
Fugitives - Mobile - Coal Pile Bulldozing	Fuel use, hours of operation, Assumed equipment
Fugitives - Welding Rod	Rod usage and equivalent emission factor profiles from USEPA AP-42
Fugitives - Abrasive Blasting	Usage and USEPA AP-42 emission factors
Emergency Generators	Brake horse power, fuel feed rate, higher heating value and source of factors
Fuel Storage Tanks	Size, shape, throughput, vapor pressure, controls
Diesel Yard Switcher Locomotive	Tier, engine size, fuel consumption, hours of operation based on USEPA AP-42 conversion factors, sulfur content
Nonroad Equipment Exhaust on Roads	Horsepower, model year, hours of operation
Onroad Vehicles Exhaust on Roads	Vehicle size, model year, vehicle miles traveled
Nonroad Equipment at Landfills	Horsepower, model year, hours of operation
Onroad Vehicles at Landfills	Vehicle size, model year, vehicle miles traveled
Wind Erosion of Coal, Ash, and Limestone Piles	Pile size (area), moisture content, meteorological data, control effectiveness

Source: Ramboll Environ 2016d.

3.1.4.2.1 Impact Assessment – Modeling Approach

Impacts on ambient air quality near NGS were evaluated using a near-field air dispersion and deposition modeling analysis to estimate the potential local air quality impacts for receptors up to 50 km from NGS. The analysis focuses on comparing the modeled impacts with the NAAQS, considering both the emissions from NGS and from background sources.

The modeling analysis included air emissions of criteria air pollutants and HAPs associated with NGS. These emissions primarily occur due to the combustion involving coal in the electric generating units 1, 2, and 3 and the material handling equipment and operations of coal, lime, and ash. Smaller amounts of criteria pollutants and HAPs are emitted from the ancillary equipment such as vehicle exhaust, the auxiliary boilers, and other sources. The analysis includes criteria pollutants and HAP emissions associated with sources at the ash disposal site located 1 mile east of NGS.

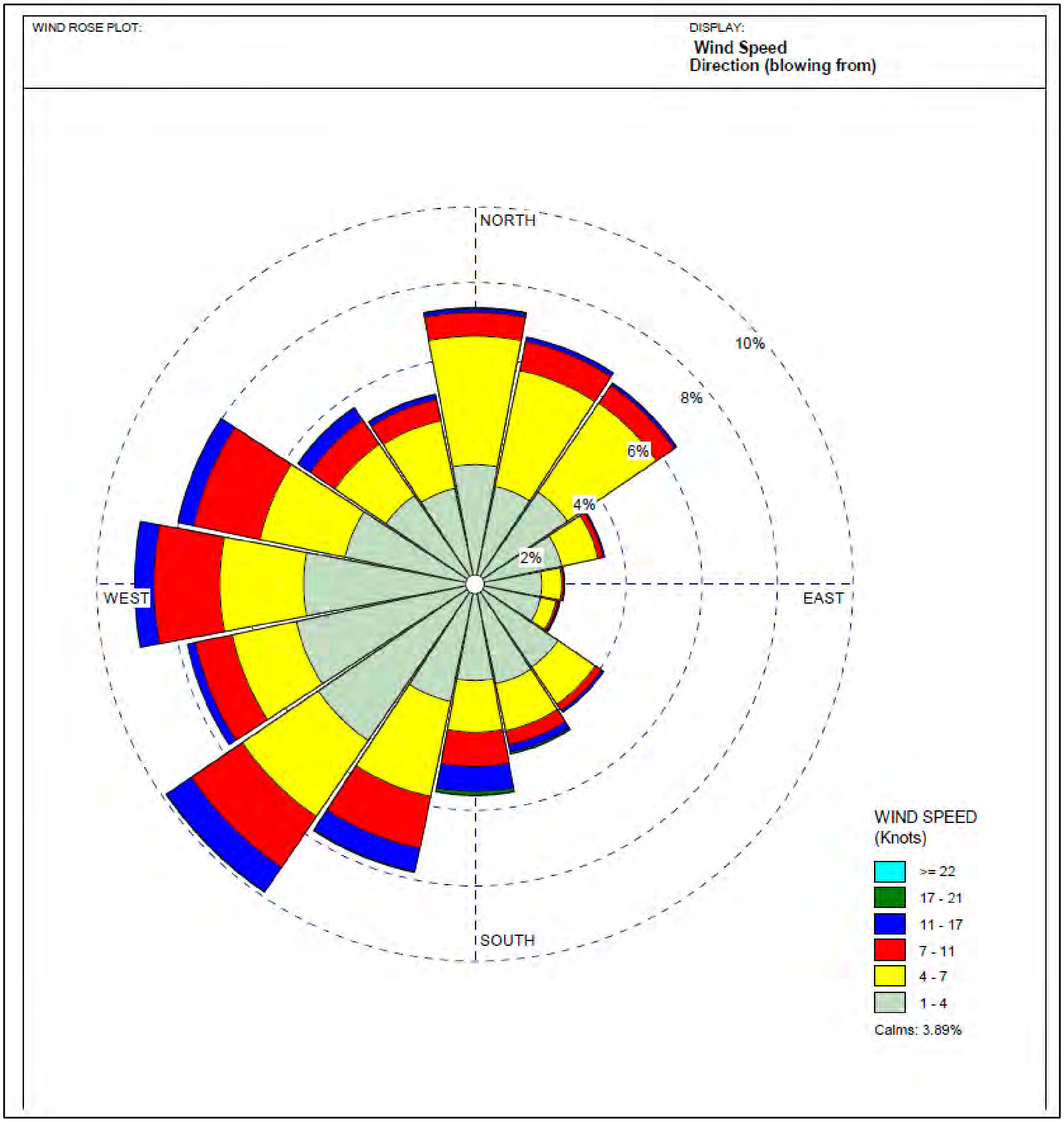
Modeling was conducted with AERMOD in accordance with the USEPA Guideline on Air Quality Models, as incorporated in Appendix W of 40 CFR Part 51. Version 14134 of AERMOD was applied. Environ (2015 [Section 3]) provides details of the modeling assumptions, setup, and input parameters. The model characterizes the emission sources as point, area, or volume configurations, depending on the nature of the emission source.

Impacts on visibility in Class I areas from NGS operation were taken from the USEPA Better than Best Available Retrofit Technology (BART) Alternative Federal Implementation Plan; therefore, impacts were not re-modeled in this analysis.

A 5-year meteorological database for 2008 through 2012 from the meteorological stations near NGS (i.e., Page Municipal Airport) was used for the dispersion and deposition modeling. This included the hourly precipitation data used in the simulations of wet deposition fluxes needed for the risk assessments as well as wind data, which influences the distribution of pollutant concentrations and hence dry and wet deposition.

A wind rose showing the wind speed and wind direction data collected at the Page Municipal Airport is provided in **Figure 3.1-9**. The wind rose indicates winds generally are from southwest and west. The average wind speed is approximately 2.4 meters per second, and winds are calm (i.e., wind speeds are less than 0.5 meters/second) for approximately 4 percent of the observations. This wind data provided the dispersion modeling input for AERMOD and depicts the influence of wind direction and wind speed on the impacts from surface level sources at NGS. As noted in the following discussion, the maximum impacts for criteria air pollutants are dominated by the low-level sources and surface operations at NGS. Impacts from the main boiler stacks also are influenced by the upper air pattern used in the AERMOD model.

For NGS existing (or background), air quality levels were taken from the Glen Canyon ambient air monitoring station, which is operated by NGS. This station is located 2.7 miles west of downtown Page, Arizona, and approximately 6 miles west-northwest of the NGS (**Figure 3.1-3**). The Glen Canyon monitoring site collects particulate matter ($PM_{2.5}$ and PM_{10}) and SO_2 ambient concentration data. Data for background ozone levels were taken from the Grand Canyon monitor, approximately 80 miles southwest of NGS. Hourly background NO_2 levels were taken from a combination of nearby monitors in Hurricane and St. George, Utah. For KMC, PM_{10} background concentrations were taken from Kayenta Mine on-site station AQ200, while NO_2 and ozone concentrations were taken from station N9. Off-site stations in Bloomfield, New Mexico; Farmington, New Mexico; and Ignacio, Colorado; provided background concentrations of SO_2, $PM_{2.5}$, and CO, respectively.



Source: Environ 2015.

Note: The concentric circles represent the annual frequency of the hourly wind direction from each of the 16 wind directions. The frequency of occurrence of each wind speed category is represented by the radial length of each speed category in each direction.

Figure 3.1-9 Wind Rose Plot for Page Municipal Airport

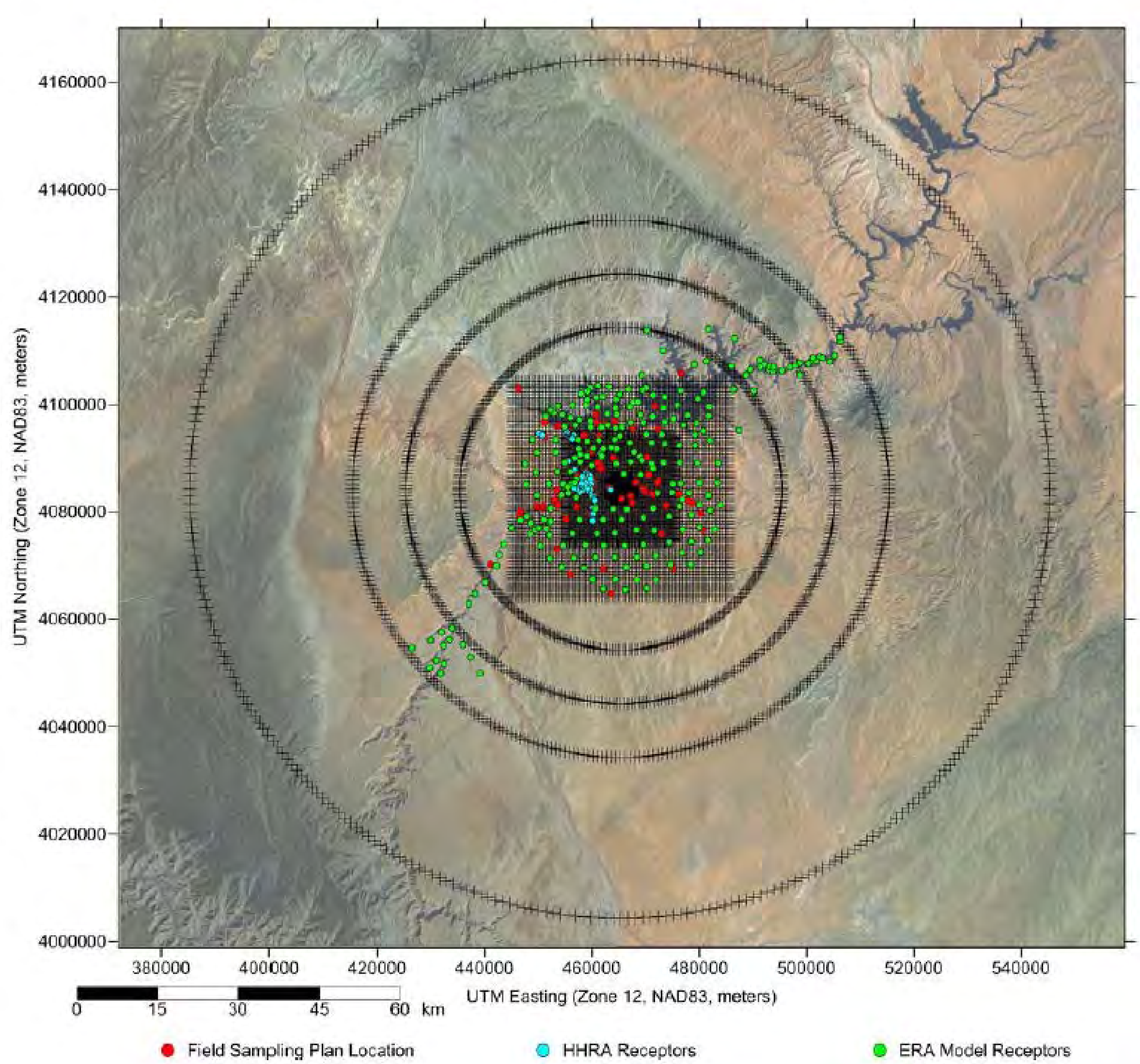
The impacts analyzed include ambient air quality conditions, regional visibility, and deposition of acidic compounds as well as hazardous or toxic air compounds. The impact analysis was based on both the expected short-term (24 hours or less) and long-term (annual) emission rate from all sources at NGS and the proposed KMC. Air quality impacts are compared to the No Action Alternative and NAAQS, and spatial depictions also are provided to evaluate the pattern of impacts. Emissions and impacts from the operation of the coal railcar delivery between the proposed KMC and NGS are negligible (Winges and Steffel 2016) and were not included in this analysis.

For both NGS and the proposed KMC, the USEPA regulatory guideline model AERMOD (the American Meteorological Society/Environmental Protection Agency Regulatory Model, Version 14134) was used to characterize the specific sources and to calculate impacts using locally applicable meteorological data (40 CFR Part 51, Appendix W). The guideline default parameters were used, with any exceptions explained in the proposed KMC Modeling Report (MMA 2016 [Section 5.0]) and the NGS AERMOD Modeling Protocol Report (Environ 2015 [Section 3.0]). This model was used to evaluate impacts at receptors within 50 km of the emissions source, and thereby serves as a local dispersion model for both NGS and the proposed KMC. The receptors used for NGS Near-field modeling is provided in **Figure 3.1-10**; residence receptors used for the proposed KMC Near-field modeling can be seen on **Figure 3.1-8** and the off-site receptors, including the permit boundary are shown in **Figure 3.1-11**.

The Kayenta Mine directly supports NGS and includes operations that generate air emissions. The AERMOD dispersion model (Version 14134) also was used in a separate analysis of impacts from mining operations, with the range of mining activity consistent with the 3-Unit Operation and 2-Unit Operation at NGS. The target production at the proposed KMC was 8.1 million tpy for the 3-Unit Operation and 5.5 million tpy of coal for the 2-Unit Operation. This model also analyzed ambient air quality impacts within 50 km of the emitting sources. Details of model setup and input preparation are provided in the proposed KMC Modeling Report Protocol (MMA 2016 [Section5.0]). The modeling effort included use of a wide range of emission factors associated with materials handling, excavation, and storage piles. The modeling also included assumptions about specific operating levels and hours of operation that are important for characterizing emissions and impacts. There are uncertainties regarding these assumed input values, but the modeling effort was based on accepted assumptions and on the details of the mine plan. Details of the assumptions are available in MMA (2016).

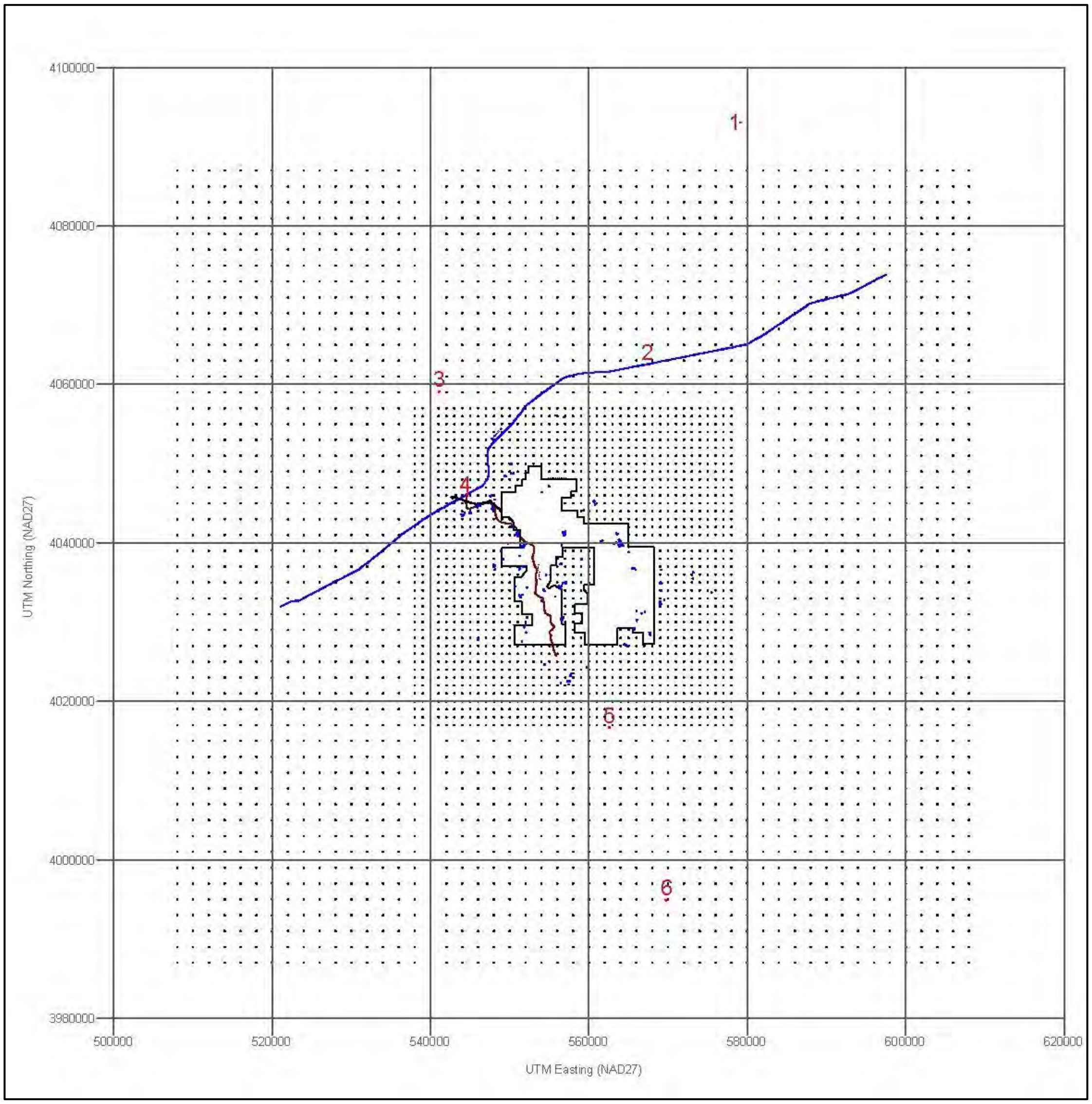
Five years of site-specific meteorological data from site BM-MET9 within the proposed KMC boundary were used for modeling, with concurrent data from the Flagstaff upper air soundings (or Albuquerque, New Mexico, as a backup).

The project is comprised of two major operations approximately 80 km apart; therefore, it was important to evaluate the additive effects of one component of the Proposed Action with the others. The proposed KMC operations mostly involve emission sources at or within 10 meters of ground level; therefore, any air quality impacts from proposed KMC that might overlap NGS would be negligible. However, given the height of the NGS stacks and the potential for long range dispersion, the impact of emissions from NGS that might overlap with the proposed KMC impacts is more likely to occur. To address that potential issue, the AERMOD model was used to determine the maximum impact from NGS emissions at any receptor at the proposed KMC as a means of characterizing that impact, and those deposition rates were used (i.e., added to the proposed KMC emissions) in the proposed KMC analysis. In addition, NGS emissions were included in background concentrations that were used in the NAAQS analysis for the proposed KMC.



Source: Ramboll Environ 2016b.

Figure 3.1-10 AERMOD Dispersion and Deposition Modeling Receptor Grid for NGS



Source: MMA 2016.

1 - Monument Valley Visitor Center
2 - Town of Kayenta
3 - Navajo National Monument
4 - Highway 160 and Navajo Route 41
5 - Forest Lake Chapter House
6 - Town of Piñon
Black dots are grid receptors; blue dots are residential receptors.

Figure 3.1-11 AERMOD Dispersion Modeling Receptor Grid for Proposed KMC

On a regional basis, the Comprehensive Air Quality Model with Extensions (CAMx) was used. CAMx includes an array of chemical and photochemical reactions that are important for the regional scale transformation of emissions in the atmosphere and was used in this environmental impact statement to evaluate NGS emissions for regional air quality impacts on ozone levels, visibility in Class II areas, and acid deposition in Class I and sensitive Class II areas.

3.1.4.2.2 Analysis Methods for Partial Federal Replacement Alternatives

Each of the Partial Federal Replacement (PFR) alternatives was evaluated based on the emissions and modeling results for the Proposed Action, using the data for the 3-Unit Operation and 2-Unit Operation. Those results were used to develop a scaling factor of emissions and impacts based on the operations and production levels for the Proposed Action at NGS and the proposed KMC. See Section 3.0 for a discussion of scaling factors. Analysis of each PFR alternative includes a reduced production level at NGS and the proposed KMC. The PFR alternatives do not include a specific limit on daily operations; therefore, the maximum daily emissions generally would not change. However, the modeled hourly and daily impacts for the 3-Unit Operation and 2-Unit Operation were used to develop a scaling factor for each of the PFRs, which was then used to estimate air quality impacts.

At NGS, the total annual average power production (in megawatts) was used to calculate a ratio for each PFR alternative to estimate the change in emissions and in modeled impacts. The maximum air quality impacts at NGS are dominated by surface level operations and occur near the ambient air quality boundary; therefore, there was very little difference in those impacts for each of the PFR alternatives except that SO_2 emissions and impacts are dominated by the three main stacks.

For the Natural Gas PFR Alternative, the natural gas replacement power would be provided by a natural gas combined cycle power plant, assumed to be similar to the facility that was permitted for the Bowie Power Plant in Arizona (Arizona Department of Environmental Quality 2014).

At the proposed KMC, the annual coal production levels for the 3-Unit Operation and 2-Unit Operation are used to develop the scaling factors for the corresponding operation of the PFR alternatives. The ratio of each of the PFR coal production alternatives to the Proposed Action coal production was then used to calculate the proposed KMC annual emissions and impacts.

3.1.4.3 Proposed Action

3.1.4.3.1 Navajo Generating Station

A range of NGS operating options included in the BART Federal Implementation Plan (79 Federal Register 46514-46555) limit air emissions to comply with the Regional Haze Rule. NO_X emissions would be reduced to achieve reasonable further progress for reducing human-induced regional haze in Class I areas. Under the Proposed Action, NGS would operate as either a 3-Unit Operation or 2-Unit Operation for the period 2020-2044. Future operational changes could include the installation of selective catalytic reduction (SCR) to reduce NO_X emissions under the 3-Unit Operation or 2-Unit Operation. The SCR control technology would be installed by 2030 for the 2-Unit Operation or by 2027 for the 3-Unit Operation. Emissions and impacts from NGS operations were assessed, including known control technology requirements. The 3-Unit Operation and 2-Unit Operation represent an upper and lower operational bound for the Proposed Action. As explained in Ramboll Environ (2016b [Section 2.4]), the range of operation to comply with the Regional Haze Rule was characterized by evaluating the lowest emitting scenario and the highest emitting scenario of the Proposed Action from an air quality perspective. If the facility were to operate at any of the other allowable emission rates within the BART Federal Implementation Plan, the air quality impacts would lie within these bounds. A detailed presentation of data used for this analysis is provided in **Appendix 3.1-D**.

This section includes a summary of emission rates and impacts for NGS. Details of the emissions data, control technology assumptions, modeling setup and configuration, and impacts are provided in Environ (2015) and Ramboll Environ (2016b,d) for NGS.

3.1.4.3.1.1 Emissions

Under the Proposed Action, the main emission sources from NGS are the stacks associated with the 3-Unit Operation or 2-Unit Operation of the individual boiler units that generate steam to produce electricity. Based on operational data and design information provided by NGS, each of the main stacks is 775 feet tall and were assumed for modeling purposes to be identical in terms of flue gas exhaust rate, temperature, and emissions of constituent gases. For each unit, emission controls include an electrostatic precipitator that controls particulate matter, a wet limestone slurry scrubber that controls SO_2, coal treatment with calcium bromide to control mercury, low-NO_X burner design to reduce NO_X emissions (both pre-and post-SCR installation), and the future installation of an SCR unit that would control NO_X emissions in the flue gas stream. Total mercury emissions, total particulate matter, and hydrogen chloride (SO_2 as a surrogate) must comply with allowable emission rates in the Mercury and Air Toxics Standards. Coal is treated with calcium bromide to ionize elemental mercury, and facilitate capture of mercury in the absorbers.

Emissions of hazardous air pollutants from the main stacks primarily are due to the presence of trace metals in the coal feedstock that also are listed as hazardous air pollutants under the Clean Air Act. The potential impact of these pollutants on the environment and human health are further addressed in the risk assessments. A total of seven selected trace metals were screened for deposition rates on soils and into water to determine those that required further evaluation in the risk assessments.

NGS is classified as a major source that generates carbon dioxide from combustion of the carbon in coal. NGS also emits methane and NO_X, which also are greenhouse gases formed in the combustion process. Although there are other listed greenhouse gases, these three compounds are the primary greenhouse gas constituents from the operation of NGS. The impacts of greenhouse gases are further discussed in Section 3.2, Climate Change.

The total annual emissions of criteria air pollutants and greenhouse gases are provided in **Table 3.1-10**. The table includes annual emissions associated with the period prior to 2020 and for both the 3-Unit Operation and the 2-Unit Operation of the Proposed Action for the years 2020 through 2044. The table also provides annual emission rates for the years both before and after the installation of SCR on the main boiler units for the 3-Unit Operation and 2-Unit Operation for those pollutants that are affected by the operation of the SCR.

Emissions of selected metals are critical to the ERAs and HHRAs. The total emission rates are provided in Ramboll Environ (2016d); however, the three metals critical to evaluation are mercury, arsenic and selenium. Total hourly emissions from the NGS main stacks for the 3-Unit Operation at 88 percent capacity (22,188 million British thermal unit per hour combined for 3 units) were used to calculate deposition and impacts to ecological resources and human health as follows:

- Mercury – 0.0266 pounds per hour
- Arsenic – 0.0306 pounds per hour
- Selenium – 0.511 pounds per hour

Detailed calculations for these and other HAP emissions are included in Ramboll Environ (2016a [Section 2.0]).

Table 3.1-10 Annual NGS Air Emissions from Electric Generating Units Main Boiler Stacks

Criteria Pollutants GHG and Target Metals	2019 Projections[1,2]	Proposed Action Pre-SCR[2]		Proposed Action Post-SCR[2]	
		3-Unit Operation (2020-2026)	2-Unit Operation (2020-2029)	3-Unit Operation (2027-2044)	2-Unit Operation (2030-2044)
	(tons per year)				
SO_2	9,719	9,719	6,479	9,719	6,479
NO_X	20,409	20,409	13,606	6,803	4,535
CO	14,578	14,578	9,719	14,578	9,719
Total PM [3]	2,916	2,916	1,944	3,017	2,046
PM_{10} [3]	2,070	2,070	1,380	2,142	1,452
$PM_{2.5}$ [3]	1,487	1,487	991	1,559	1,064
H_2SO_4 mist	47.180	47.180	31.453	330.960	220.640
NH_4 (slip)	0.000	0.000	0.000	19.742	13.162
VOC	244.028	244.028	162.685	244.028	162.685
Arsenic	0.133	0.133	0.089	0.133	0.089
Lead	0.320	0.320	0.214	0.320	0.214
Mercury	0.117	0.117	0.078	0.117	0.078
Selenium	2.237	2.237	1.491	2.237	1.491
GHG (CO_2e)	20,088,469	18,108,000	12,072,000	18,108,000	12,072,000
	(pounds per hour)				
SO_2	2,219	2,219	1,479	2,219	1,479
NO_X	4,660	4,660	3,106	1,553	1,035
H_2SO_4 mist	11	11	7	76	50

1 Represents 3-Unit Operation pre-SCR and is based on data provided by Salt River Project Agricultural Improvement and Power District (SRP) for option B2_A.

2 Based on an annual capacity factor of 88 percent.

3 Includes particulate sulfate and ammonium produced by NH_3 interaction.

GHG = greenhouse gas.

CO_2e = carbon dioxide equivalent.

H_2SO_4 = sulfuric acid.

lb/hour = pounds per hour.

NH_4 = ammonium.

Source: Ramboll Environ 2016d.

Emissions from support operations at NGS were included in the assessment of air quality impacts and ecological and human health risk assessments. Impacts from rail operations were not included because they have been determined to be negligible (Winges et al. 2016). These operations and emission rates are provided in **Table 3.1-11** for 3-Unit Operation and represent any year of the 3-Unit Operation from 2020 to 2044.

Table 3.1-11 NGS Emissions from Other Sources – 3-Unit Operation

Operation or Source	Emission Rate (tpy)						
	NO_X	SO_2	PM	PM_{10}	$PM_{2.5}$	CO	VOC
Electric generating units oil-fired	12.09	0.14	<0.01	<0.01	<0.01	2.52	0.10
Water cooling towers	-	-	19.22	0.86	0.02	-	-
Auxiliary boilers	0.48	0.14	0.04	0.02	0.00	0.10	0.00
Coal handling and storage (no coal pile)	-	-	0.61	0.21	0.03	-	-
Coal handling and storage - coal pile materials handling	-	-	1.81	0.63	0.10	-	-
Limestone handling and storage	-	-	0.09	0.09	0.01	-	-
Limestone handling and storage - dust collectors	-	-	1.47	1.47	0.40	-	-
Fly ash handling (no disposal site)	-	-	15.64	7.82	1.18	-	-
Fly ash handling - disposal site materials handling	-	-	0.68	0.24	0.04	-	-
Soda ash/lime handling	-	-	0.17	0.17	0.03	-	-
Fugitives - mobile	-	-	200.75	50.10	5.85	-	-
Fugitives - mobile - coal pile bulldozing			33.30	8.94	0.73		
Fugitives - welding rod	-	-	0.10	0.10	0.10	-	-
Fugitives - abrasive blasting	-	-	1.85	0.44	0.04	-	-
Emergency generators	8.47	0.56	0.65	0.60	0.60	1.83	0.68
Fuel storage tanks	-	-	-	-	-	-	1.77
Diesel yard switcher locomotive	0.13	0.00	0.00	0.00	0.00	0.23	0.01
Nonroad equipment exhaust on roads	35.18	0.31	2.25	2.07	2.01	14.95	3.29
Onroad vehicles exhaust on roads	1.04	0.00	0.06	0.05	0.04	3.32	0.18
Nonroad equipment at landfills	1.00	0.02	0.08	0.07	0.07	0.49	0.08
Onroad vehicles at landfills	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wind erosion of coal, ash, and limestone piles	-	-	134.16	28.17	4.23	-	-

Source: Ramboll Environ 2016d.

3.1.4.3.1.2 AERMOD Model Results

Results of the AERMOD modeling for NGS criteria air pollutants are provided in **Table 3.1-12** for the 3-Unit Operation and in **Table 3.1-13** for the 2-Unit Operation. The data represent the maximum impacts for either pre-SCR installation or post-SCR installation for the individual (3-Unit or 2-Unit) operations. The NO_2 impacts are conservatively based on the pre-SCR model results, as these emissions would be substantially reduced by the installation of SCR. The PM_{10} and $PM_{2.5}$ model results are conservatively based on the post-SCR model results, which include added ammonium, nitrate, and sulfate emissions from the operation of the SCR. The highest impacts tend to occur in the immediate vicinity of NGS for all criteria pollutants except SO_2, as noted in **Tables 3.1-12** and **3.1-13**. The near-field maximum model results for all pollutants except SO_2 are dominated by impacts from surface level sources that operate at the NGS facility, within 800 meters to 850 meters from the site boundary. Therefore, because the operations and emissions from the daily surface sources would not be affected by the 3-Unit Operation or 2-Unit Operation, there is little difference between the maximum1-hour or 24-hour impacts for NO_2, CO, PM_{10}, and $PM_{2.5}$ for the two operations. NO_X and PM_{10}/$PM_{2.5}$ impacts occur largely from heavy equipment exhaust and fugitive emissions at the plant site and not from the main boiler stack emissions. Impacts from SO_2 emissions are dominated by the main stack plumes, with peak maximum impacts occurring at approximately 8.3 km to the southeast of NGS.

The spatial depiction of maximum impacts also is relevant to evaluating the environmental consequences of the Proposed Action. The impact at the maximum receptor may be used for evaluation of compliance with the standards, but impacts at other receptors are notably less than the maximum receptor. Detailed spatial depictions of maximum impacts at other receptors are provided in Ramboll Environ (2016b [Section 5.0, Figures 5-1 through 5-33]) for all criteria air pollutants.

Table 3.1-12 Modeled Air Quality Impacts from AERMOD 3-Unit Operation

Pollutant	Primary or Secondary Standard (μg/m³)	Averaging Time	Concentration (μg/m³)			Location of Max Impact[2]	% of NAAQS
			Modeled Impact[1]	Background	Total Impact[1]		
NO_2	188	1-hour	186.4	—[3]	186.4	844.6, ESE	99
NO_2	100	Annual	14.4	6.0	20.4	807.8, ESE	20
CO	40,000	1-hour	746.5	3,664.0	4,410.5	850.6, ESE	11
CO	10,000	8-hour	154.6	2,633.5	2,788.1	822.8, ESE	28
SO_2	196	1-hour	141.1	22.5	163.6	8267, ESE	83
SO_2	1,310	3-hour	81.4	24.6	106.0	8375, SE	8
PM_{10}	150	24-hour	94.4	44.5	138.9	826.8, ESE	93
$PM_{2.5}$	35	24-hour	11.9	20.8 [4]	32.7	826.8, ESE	94
$PM_{2.5}$	12	Annual	1.8	5.9 [5]	7.6	807.8, ESE	64
Lead	0.15	Quarterly	0.0007	0.0100	0.0107	808.6, ESE	7

[1] Maximum modeled impacts for NAAQS compliance based on the greater of the pre-SCR and post-SCR model-calculated results.

[2] Simple direction and distance in meters from NGS middle stack.

[3] NO_2 1-hour was modeled in AERMOD with seasonal, hourly background values (Ramboll Environ 2016b [Figure 4-2]).

[4] $PM_{2.5}$ 24-hour background includes 1.0 μg/m³ secondary aerosol formation.

[5] $PM_{2.5}$ annual background includes 0.26 μg/m³ secondary aerosol formation.

Source: Ramboll Environ 2016b.

Table 3.1-13 Modeled Air Quality Impacts from AERMOD 2-Unit Operation

Pollutant	Primary or Secondary Standard (µg/m^3)	Averaging Time	Concentration (µg/m^3)			Location of Max Impact[2]	% of NAAQS
			Modeled Impact[1]	Background	Total Impact[1]		
NO_2	188	1-hour	186.4	--[3]	186.4	844.6, ESE	99
NO_2	100	Annual	12.2	6.0	18.1	807.8, ESE	18
CO	40,000	1-hour	746.5	3,664.0	4,410.5	850.6, ESE	11
CO	10,000	8-hour	154.6	2,633.5	2,788.1	822.8, ESE	28
SO_2	196	1-hour	95.3	22.5	117.9	8267, ESE	60
SO_2	1,310	3-hour	54.1	24.6	78.7	8375, SE	6
PM_{10}	150	24-hour	93.2	44.5	137.7	826.8, ESE	92
$PM_{2.5}$	35	24-hour	11.8	20.8[4]	32.6	826.8, ESE	93
$PM_{2.5}$	12	Annual	1.6	5.9[5]	7.4	807.8, ESE	62
Lead	0.15	Quarterly	0.0006	0.0100	0.0106	808.6, ESE	7

1 Maximum modeled impacts for NAAQS compliance based on the greater of the pre-SCR and post-SCR model-calculated results.

2 Simple direction and distance in meters from NGS middle stack.

3 NO_2 1-hour was modeled in AERMOD with seasonal, hourly background values (Ramboll Environ 2016b [Figure 4-2]).

4 $PM_{2.5}$ 24-hour background includes 1.0 µg/m³ secondary aerosol formation.

5 $PM_{2.5}$ annual background includes 0.26 µg/m³ secondary aerosol formation.

Source: Ramboll Environ 2016b.

The identification of the highest impacts nearest to the ambient standards for the NGS 3-Unit Operation can be extracted from the tables. The maximum predicted 1-hour NO_2 impact at an individual receptor would occur at the NGS boundary, at a level that is just below the ambient air quality standard. The 1-hour NO_2 impacts rapidly decline with distance from NGS. The 1-hour NO_2 impacts would be less than half the standard (approximately the 100 µg/m^3 contour line) beyond approximately 2.5 km (1.6 miles) in any direction from NGS (Ramboll Environ 2016b [Figure 5-2]).

Tables 3.1-12 and **3.1-13** also indicate that the background levels of $PM_{2.5}$ tend to dominate the impacts, and those background levels are below (approximately half) the ambient standard. Maximum impacts from NGS on ambient concentrations of $PM_{2.5}$ also are confined to receptors very near the NGS boundary. The 24-hour maximum $PM_{2.5}$ impact would occur at the NGS boundary, and the impacts rapidly decline with distance from NGS. Within 1 km from the NGS boundary, the maximum impact would be reduced from 32.7 µg/m^3 to approximately 24 µg/m^3, and impacts in all other directions would be well below the ambient standard.

It is important to emphasize that the maximum hourly impacts on NO_2 levels at NGS for all operations would not be affected by the installation of SCR in either operation or by the implementation of the 3-Unit Operation or 2-Unit Operation. These maximum impacts are dominated by the surface level NO_X emissions from ground operations, such as vehicle emissions and emissions from fuel burning equipment associated with coal handling. The maximum impacts would occur near the NGS ambient air boundary. Hourly operations of these units, and thereby maximum hourly NO_X emissions, would be unchanged for the pre- and post-SCR period and by the selection of the 3-Unit Operation or 2-Unit Operation. Ambient NO_2 concentrations at more distant receptors affected mainly by NO_2 emissions from the stacks would be reduced for the 2-Unit Operation and following SCR installation for both the 3-Unit Operation and 2-Unit Operation.

Fundamentally the analysis demonstrates that the Proposed Action, including options, would comply with the NAAQS for the criteria air pollutants (NO_2, CO, SO_2, PM_{10}, and $PM_{2.5}$). As shown in the figures in Ramboll Environ (2016b [Section 5.0]), the maximum impacts would occur very near the NGS ambient air boundary, and those impacts would decrease substantially with distance from that boundary. The results are a conservative estimate of actual impacts because conservative technical approaches provide results that likely over-estimate impacts.

Ambient air quality impacts from NGS operations would be moderate because the air quality effects would be readily apparent and would result in measurable impacts to the resource. However, all criteria pollutant impacts would be in compliance with NAAQS. Except for SO_2, the impacts would be dominated by ground-level operations, close to the ambient standards near the facility ambient air boundary, and decrease with distance to less than half of the ambient standards beyond 10 km from the facility. SO_2 impacts also would be in compliance with the standards, but the peak impacts would be limited to a very small area of high terrain to the southeast of NGS.

3.1.4.3.1.3 Air Quality and Deposition Impacts of Selected Metals

Trace metals are emitted from NGS operations including the fuel burned from surface equipment and vehicle operations, the metals in the coal that are emitted from the main stack, and the metals in coal and ash that are emitted from fugitive sources on site. The dispersion, ambient air quality levels, and deposition of these metals were evaluated to determine potential impacts from the Proposed Action and action alternatives on local biological receptors and human populations. The emission, dispersion, and deposition of those metals are analyzed in this section and used for input to the ERAs and HHRAs.

As noted above, the AERMOD model was used to determine air quality concentrations and deposition rates for HAP metals emitted from NGS, including both the main stack and process/handling emissions. **Table 3.1-14** provides the maximum impact at any receptor within 50 km from NGS for both ambient air quality impacts and deposition rates associated with the 3-Unit Operation. A spatial analysis of impacts (Ramboll Environ 2016b [Figures 5-35 and 5-36]) depicts the rate of change with distance from NGS, with these maximum values located at or near the NGS ambient air boundary. The impacts would decrease rapidly with distance from the NGS boundary.

Table 3.1-14 Maximum Impact and Deposition of HAP Metals from NGS Emissions

Pollutant	Averaging Period	Maximum Air Impact ($\mu g/m^3$)	Maximum Deposition (kg/hectare-year)
Arsenic	Annual	0.0000373	0.00088
Lead	Annual	0.000287	0.00303
Mercury	Annual	0.00000274	0.0000126
Selenium	Annual	0.000604	0.00655

Source: Ramboll Environ 2016b.

3.1.4.3.1.4 Air Quality Impacts at Class I Areas

The USEPA issued a Federal Implementation Plan to address regional haze impacts from NGS emissions on Class I areas within the study area under the Regional Haze Rule (40 CFR Part 49.5513). The Federal Implementation Plan addressed requirements for installation of BART on NGS to improve visibility in 11 Class I areas, and required the NGS operator to achieve NO_X emissions reductions to comply with the 2009-2044 NO_X emissions cap. The final action implemented the better than BART alternative that was consistent with an agreement developed by a joint Technical Working Group. SCR would be installed on units to comply with an emissions cap for NO_X for the period 2020-2029. USEPA's analysis of impacts at the 11 Class I areas is provided in the Federal Register (78 Federal Register 8286) for the original BART analysis. As shown in **Table 3.1-15**, the results showed improvement in visibility in the 98th percentile at all 11 Class I areas (from 2003 data). See the Federal Register publication (79 Federal Register (153) 46514-46555) for additional details on the Final Rule.

Table 3.1-15 USEPA Modeling Results

Class I Area	Distance to NGS (km)	Baseline Impact[1] (dV)	Improvement[1,2] (dV)	Improvement[1,2] Percent
Arches National Park	245	4.5	3.5	77
Bryce Canyon National Park	96	4.9	3.6	74
Canyonlands National Park	173	6.0	4.6	76
Capitol Reef National Park	90	7.7	5.4	71
Grand Canyon National Park	29	8.4	5.4	64
Mazatzal Wilderness Area	279	1.5	1.1	75
Mesa Verde National Park	253	3.2	2.6	81
Petrified Forest National Park	235	3.4	2.7	78
Pine Mountain Wilderness Area	287	1.3	1.0	75
Sycamore Canyon Wilderness Area	204	2.4	1.8	75
Zion National Park	134	4.4	3.3	76

[1] From 98th percentile delta deciviews.

[2] Improvement from SCR plus low-NO_X burners and supplemental over fire air for NO_X controls.

Source: CSU 2016; 78 Federal Register 8287.

Improvement is based on reduced impacts after 2018, but as discussed in the Federal Implementation Plan, the USEPA allows credit for reduced NO_X emissions from 2009 through 2019 and established a NO_X emission limit of 0.07 pounds/million British thermal unit. Therefore, the improvement with the better than BART alternative could be less than originally described for the individual years, but the better than BART alternatives would provide overall reduced impacts for the extended time period. The visibility impact analysis for the 0.07 pounds/million British thermal unit NO_X emission rate was not specifically analyzed.

The impacts of NGS on Class I areas would be moderate because impacts were calculated to remain above 1.0 deciviews; however, these impacts would be mitigated by 60 to 80 percent by the installation of SCR on the 3-Unit Operation by 2026 or on the 2-Unit Operation by 2030.

NGS has not been required to obtain a permit under the Prevention of Significant Deterioration regulations; therefore, they are not increment consuming facilities. As a result, their impacts on ambient air quality in Class I areas were not evaluated for comparison to those Class I increments. The existing ambient air quality conditions at those locations already reflect the impacts from historic and ongoing operations at NGS.

3.1.4.3.1.5 Plume Blight from NGS Emissions

Plume blight is defined as visual impairment of air quality that manifests itself as a coherent plume. This results from specific sources, such as a power plant smoke stack, emitting pollutants into a stable atmosphere. The pollutants are then transported in some direction with little or no vertical mixing. (Malm, 1999). Under stable meteorological conditions and current emissions, a viewer facing the Navajo Generating Station plume from vantage points within 50 km of NGS may see a discreet plume for some distance from the stack. Features of the plume will vary as a function of meteorological conditions and viewer position and distance from the facility.

3.1.4.3.1.6 Regional Haze at Nearby Areas

The impact of NGS at the Class II areas within 300 km of NGS also is reflected in existing air quality and haze conditions at those locations. A separate haze analysis is not mandated by federal or other agency requirements for these Class II areas in which visibility has not been identified as an important environmental resource, and was not conducted.

3.1.4.3.1.7 Indirect Effects from NGS

Indirect air quality effects from the Proposed Action largely would include the continued delivery of materials and chemicals to NGS, as well as hauling of coal combustion residuals off site to customers or to a separate landfill. During the Proposed Action period (2020-2044), NGS would continue to receive chemicals and support products. During the course of the Proposed Action, NGS also would begin receiving anhydrous ammonia or urea for use in the SCR system. The additional air quality effects from the added truck traffic are limited to the extra deliveries of ammonia. The impacts from truck traffic from existing operations would continue, or could be reduced under the 2-Unit Operation. On an annual basis, delivery of most chemicals and other feedstocks would be proportional to the expected power generation at NGS. With reduced power production for the 2-Unit Operation, the annual level of deliveries of materials and overall truck traffic would be reduced roughly comparable to the related reduction in power production.

The effect of indirect activities in support of NGS would be minor because the air quality effects of materials delivery would involve traffic on public highways, and emissions would have transient impacts at any specific location. The effect of traffic emissions (not specific to NGS indirect activities) was included in the photochemical grid modeling that was conducted for cumulative effects.

Under the Proposed Action 2-Unit operation, one of the electric generating units would be decommissioned along with any structures related specifically to that unit. At that time, any planning for salvage, sale, repurposing, abandonment in place, or demolition would be reviewed. It also is possible that under this operation, no demolition would occur until the facility as a whole is decommissioned. Except for demolition, there would be no or negligible air quality emissions. However, because the remainder of the facility would be operating under the Proposed Action, demolition activities would be limited in area and likely very brief. A quantitative assessment of those emissions or impacts is not possible with available data, but the air quality impacts likely would be negligible, particularly in relation to all other ongoing activities that support the 2-Unit Operation.

Additionally, under the Proposed Action, the entire NGS facility would be decommissioned at the end of the lease period (2044) unless the Navajo Nation elects to operate the station beyond 2044. If NGS is decommissioned, the lease requires that the land be restored as closely as possible to the original condition, requiring extensive demolition of most of the existing structures and facilities. Following any asbestos abatement, the remaining structures and equipment that were not recycled or salvaged would be dismantled and demolished, and all fuel, chemicals, waste, coal and other materials would be removed for disposal. Demolished inert materials would be buried in an on-site area, and covered by a stabilized surface with natural features in place above the disposal and abandonment area. From an air quality perspective, emissions would involve fugitive dust from demolition activities, soil handling, coal removal, and disposal and remediation activities. There also would be engine exhaust emissions from heavy equipment operations during demolition and surface activities. Given the nature of surface emissions at NGS for normal operations, including fugitive particulate matter and equipment exhaust, impacts within a few kilometers of the facility likely would be similar to those of normal operation. Impacts would be moderate at times during major activities of relatively short duration (i.e., approximately 1 year).

3.1.4.3.2 Proposed Kayenta Mine Complex

3.1.4.3.2.1 Emissions from Proposed KMC

Proposed KMC operations include a wide array of sources related to coal mining, handling and processing. Emissions of criteria pollutants are generated by mining operations (coal and overburden removal and transport), coal preparation plant activities (coal transfers, crushing, screening, stockpiling) and wind erosion of stockpiles and disturbed areas. The majority of these emissions consist of fugitive and process particulate matter (total suspended particulates, PM_{10}, and $PM_{2.5}$). Other pollutants (NO_X, CO, and SO_2) are generated by blasting and from tailpipe exhaust from mining equipment and haul trucks. Emission rates (annual and maximum 24-hour) were estimated using standard emission factor approaches in conjunction with design and operational parameters provided by Peabody Western Coal Company. Vehicle and equipment tailpipe emissions from fuel combustion were based on USEPA's NONROAD emission model, using equipment fleet characteristics for the modeled year. Coal and overburden blasting emissions were calculated using emission factors from AP-42 Section 13.3, which is based on the tons of explosives used in each charge: NO_X = 17 pounds/ton, CO = 67 pounds/ton, and SO_2 = 0.01 pounds/ton. Pollution controls on fugitive particulate matter sources, as applied at the proposed KMC, were taken into account when quantifying pollutant emission rates. The particulate matter emitting sources are listed in **Table 3.1-16**, along with emission factors, controls, and control effectiveness. Emission factors for PM_{10} and $PM_{2.5}$ include adjustments for particle size distribution where appropriate and were included when calculating those emissions.

Annual emission inventories for total suspended particulates, PM_{10}, and $PM_{2.5}$ were developed for each year of the period 2020-2044. Worst-case years for modeling were selected using these inventories and the proposed KMC mine plan maps, as described in MMA (2016 [Section 4.5]), based on the mine operations and proximity to the mine boundaries. Emissions were apportioned to the individual mining and preparation areas for the years modeled.

Table 3.1-16 Particulate Matter Emission Sources, Factors, and Controls

PM Sources	Factor	Factor Reference	Controls	Control Effectiveness
Prep Area				
Truck dumping	0.000294 pounds/ton	USEPA AP-42 Section 13.2.4	None	0
Hopper loading	0.000294 pounds/ton	USEPA AP-42 Section 13.2.4	Water Sprays	50%
Transfer points	2.10 X 10-5 pounds/ton	USEPA AP-42 Section 13.2.4	Water/Chemical+Enclosures	95%
Primary crushing	0.0012 pounds/ton	USEPA AP-42 Table 11.9.2-2	Controlled factor	included
Secondary crushing	0.0012 pounds/ton	USEPA AP-42 Table 11.9.2-2	Controlled factor	included
Screening	0.0022 pounds/ton	USEPA AP-42 Table 11.9.2-2	Controlled factor	included
Sample crushing	0.0030 pounds/ton	USEPA AP-42 Table 11.9.2-2	Controlled factor	included
Wheeled dozers	36.582 pounds/hour	USEPA AP-42 Table 11.9-1	None	0

Table 3.1-16 Particulate Matter Emission Sources, Factors, and Controls

PM Sources	Factor	Factor Reference	Controls	Control Effectiveness
Pile wind erosion	Varies	USEPA AP-42 Section13.2.5	NA	NA
Coal Pit Areas				
Coal removal	0.0021 pounds/ton	WDEQ 1979	None	0
Overburden removal (shovel)	0.015 pounds/ton	WDEQ 1979	None	0
Overburden removal (dragline)	0.030 pounds/yard^3	WDEQ 1979	None	0
Scrapers	26.827 pounds/hour	WDEQ 1979	Watering	50%
Overburden drilling	1.3 pounds/hole	USEPA AP-42 Table 11.9-4	Operations	90%
Overburden blasting	37.5 pounds/blast	WDEQ 1979	None	0
Coal drilling	0.22 pounds/hole	USEPA AP-42 Table 11.9-4	Operations	90%
Coal blasting	26.25 pounds/blast	WDEQ 1979	None	0
Overburden haul roads	2.263 pounds/vehicle mile traveled	WDEQ 1979	Watering/Dust Suppressant	60%
Coal haul roads	4.023 pounds/vehicle mile traveled	WDEQ 1979	Watering/Dust Suppressant	60%
Dozers on Overburden	3.941 pounds/hour	USEPA AP-42 Table 11.9-1	None	0
Graders	26.827 pounds/hour	WDEQ 1979	Watering	50%
Water trucks	1.006 pounds/vehicle mile traveled	WDEQ 1979	Watering/Dust Suppressant	60%
Wind erosion	0.25 ton/acre-year	WDEQ 1979	None	0

WDEQ = Wyoming Department of Environmental Quality.

Source: MMA 2014.

Tables 3.1-17 and **3.1-18** present the total annual emissions from the proposed KMC for the years modeled under the 8.1 million tpy and 5.5 million tpy production, respectively. Note the years modeled for the 8.1 million tpy production rates were 2027 and 2042, while the 5.5 million tpy production was modeled for 2022 and 2043.

Table 3.1-17 Total Emissions for the 8.1 Million tpy Production

Operation or Source	Emissions (tpy)					
	NO_X	CO	SO_2	PM	PM_{10}	$PM_{2.5}$
Year 2027						
Coal preparation facilities	0	0	0	161	46	4.3
Mining fugitive emissions	0	0	0	2,147	633	88
Scoria fugitive emissions	0	0	0	14	4.2	1.2
Blasting	126	498	0.1	5	1.5	0.1
Equipment exhaust	493	37	0.7	8	8	8
Total	619	535	1	2,335	692	101
Year 2042						
Coal preparation facilities	0	0	0	157	45	4.1
Mining fugitive emissions	0	0	0	2,797	817	115
Scoria fugitive emissions	0	0	0	14	4.2	1.2
Blasting	239	943	0.1	5	1.5	0.1
Equipment exhaust	560	31	0.8	8	8	8
Total	799	974	1	2,981	876	128

Source: MMA 2014.

Table 3.1-18 Total Emissions for the 5.5 Million tpy Production

Operation or Source	Emissions (tpy)					
	NO_X	CO	SO_2	PM	PM_{10}	$PM_{2.5}$
Year 2022						
Coal preparation facilities	0	0	0	141	40	3.7
Mining fugitive emissions	0	0	0	1,949	576	81
Scoria fugitive emissions	0	0	0	14	4.2	1.2
Blasting	77	303	0.1	3.3	1.0	0.1
Equipment exhaust	346	50	0.5	8	8	8
Total	423	353	1	2,115	629	94
Year 2043						
Coal preparation facilities	0	0	0	140	39	3.6
Mining fugitive emissions	0	0	0	2,275	670	94
Scoria fugitive emissions	0	0	0	14	4.2	1.2
Blasting	116	456	0.1	3.3	1.0	0.1
Equipment exhaust	364	20	0.5	5	5	5
Total	480	476	1	2,437	719	104

Source: MMA 2014.

3.1.4.3.2.2 Modeled Impacts

AERMOD was applied to calculate airborne concentrations for each pollutant resulting from the proposed KMC emissions for each of the two worst-case years and for each production operation. A combination of volume and area source characterizations was used to represent the mine sources. Haul roads were characterized as a series of volume sources. Receptors for modeling impacts were placed at the proposed KMC boundary and at residences located both inside and outside of the mine lease area. **Figure 3.1-8** depicts the residence receptors. Beyond the boundary, the receptor grid extended over a 100-km by 100-km grid using a set of nested grid receptors as displayed in **Figure 3.1-11**. Background air quality concentrations were based on data collected at the proposed KMC or at regional stations either representative of remote locations or conservative estimates of the regional background. The impacts of emissions from NGS that might overlap with the proposed KMC impacts were accounted for by adding the deposition rates at any receptor at the proposed KMC to the KMC emissions in the proposed KMC analysis. In addition, NGS emissions were included in background concentrations that were used in the NAAQS analysis for the proposed KMC.

Impacts were assessed by selecting the highest modeled design concentration for each respective criteria air pollutant and averaging time at any of the receptors. Most of the maximum impacts would occur near the proposed KMC lease boundary. The maximum modeled design concentrations at the boundary and grid receptors are provided in **Table 3.1-19** and the maximum modeled design concentrations at the residence receptors are provided in **Table 3.1-20**. Emissions from blasting were not included in modeling the 1-hour impacts for NO_2, CO, or SO_2 because they would be intermittent, highly variable, and occur for only a small fraction of any 1-hour period (MMA 2016 [Section 5.6]). All model results indicate that the impacts, including the monitored background concentrations, would be below the ambient air quality standards.

Table 3.1-19 Maximum Modeled Design Concentrations at Proposed KMC Boundary and Grid Receptors

		Modeled Design Concentration (µg/m³)			Total Concentration and Percent of NAAQS				
					5.5 million tpy		8.1 million tpy		
Pollutant	**Averaging Time**	**5.5 million tpy**	**8.1 million tpy**	**Background[1] Concentration (µg/m³)**	**(µg/m³)**	**(%)**	**(µg/m³)**	**(%)**	**NAAQS (µg/m³)**
NO_2	1-hour[2]	131.4	146.7	included	131.4	70	146.7	78	188
NO_2	Annual[3]	9.7	8.8	5.6	12.3	12	14.4	14	100
CO	1-hour[4]	64.7	65.8	1,955.0	2,019.7	5	2,020.8	5	40,000
CO	8-hour[4]	3,282.6	3,521.4	1,495.0	4,777.6	48	5,016.4	50	10,000
SO_2	1-hour[5]	0.4	0.7	22.7	23.1	12	23.4	12	195
SO_2	3-hour[4]	1.0	1.6	19.1	20.1	2	20.7	2	1300
PM_{10}	24-hour[6]	50.7	69.4	33.7	84.4	56	103.1	69	150
$PM_{2.5}$	24-hour[7]	6.8	5.7	13.0	19.8	57	18.7	53	35
$PM_{2.5}$	Annual[8]	1.3	1.2	4.7	6.0	50	5.9	49	12

[1] Represents monitored background concentrations, including contributions from NGS.
[2] 5-year mean of 8th highest daily maximum.
[3] Maximum annual over 5 years.
[4] Highest 2nd high over 5 years.
[5] 5-year mean of the 4th highest daily maximum.
[6] Highest 6th high over 5 years.
[7] 5-year mean of the highest 8th high.
[8] Maximum of the 5-year mean.
Source: MMA 2016.

Table 3.1-20 Maximum Modeled Design Concentrations at Proposed KMC Residence Receptors

Pollutant	Averaging Time	Modeled Design Concentration (μg/m^3)		Background[1] Concentration (μg/m^3)	Total Concentration and Percent of NAAQS				NAAQS (μg/m^3)
		5.5 million tpy	8.1 million tpy		5.5 million tpy		8.1 million tpy		
					(μg/m^3)	(%)	(μg/m^3)	(%)	
NO_2	1-hour[2]	114.3	125.5	included	114.3	61	125.5	67	188
NO_2	Annual[3]	5.3	7.8	5.6	10.9	11	13.4	13	100
CO	1-hour[4]	34.8	22.5	1,955.0	1,989.9	5	1,977.5	5	40,000
CO	8-hour[4]	1,615.9	1,82.9	1,495.0	3,110.9	31	2,777.9	28	10,000
SO_2	1-hour[5]	0.18	0.3	22.7	22.9	12	23.0	12	195
SO_2	3-hour[4]	0.6	0.5	19.1	19.7	2	19.6	2	1300
PM_{10}	24-hour[6]	28.7	34.8	33.7	62.4	42	68.5	46	150
$PM_{2.5}$	24-hour[7]	3.4	4.0	13.0	16.4	47	17.0	49	35
$PM_{2.5}$	Annual[8]	0.8	1.0	4.7	5.5	46	5.7	48	12

[1] Includes modeled contributions from NGS.

[2] 5-year mean of 8th highest daily maximum.

[3] Maximum annual over 5 years.

[4] Highest 2nd high over 5 years.

[5] 5-year mean of the 4th highest daily maximum.

[6] Highest 6th high over 5 years.

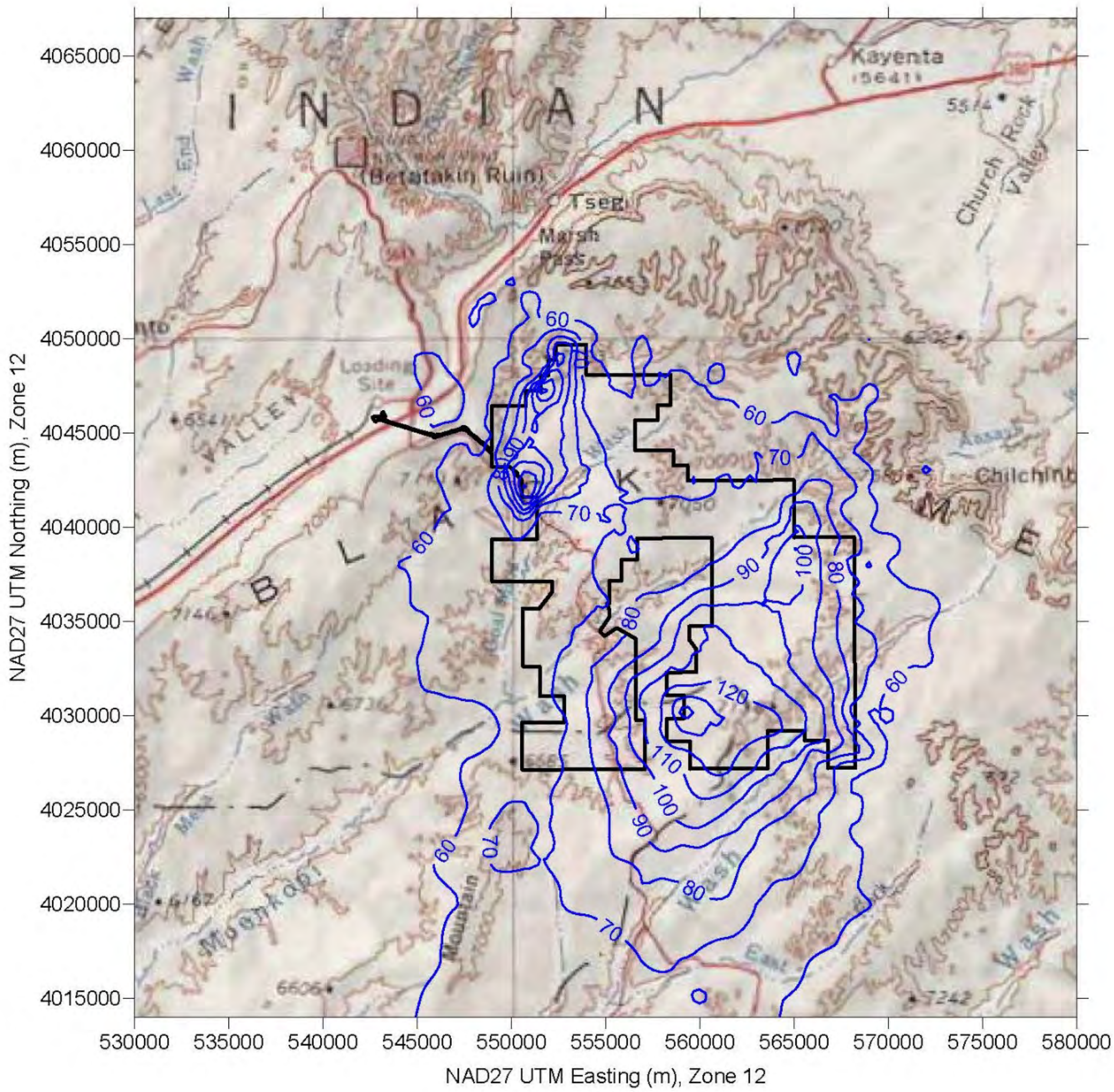
[7] 5-year mean of the highest 8th high.

[8] Maximum of the 5-year mean.

Source: MMA 2016.

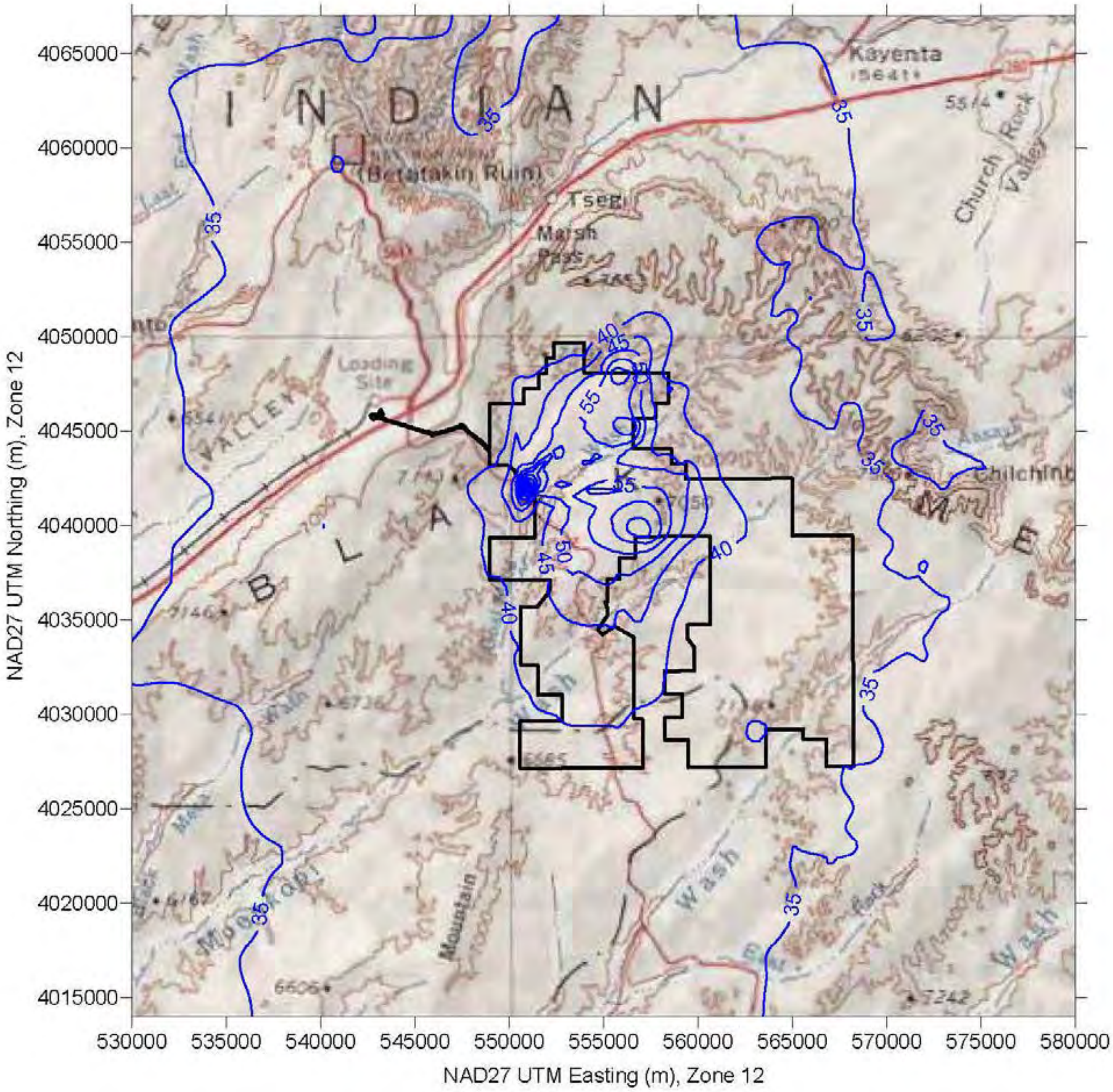
Most of the modeled impacts are less than half the ambient standard. The 1-hour NO_2, 24-hour PM_{10}, and 24-hour $PM_{2.5}$ at the proposed KMC boundary and grid receptors would be above half the NAAQS and up to 78 percent, 69 percent, and 57 percent of the standard, respectively. At the proposed KMC residence receptors, only the NO_2 impacts were above half the NAAQS and up to 67 percent of the standard. For clarity and evaluation, the spatial pattern of impacts for the maximum year of impact are depicted in **Figures 3.1-12** through **3.1-14** for 1-hour NO_2 for 2027, 24-hour PM_{10} for 2042, and 24-hour $PM_{2.5}$ for 2027, respectively. All patterns show that the maximum impacts would be concentrated near specific sources on the mine lease area. The pattern of impacts for other years would be different but still characterized in a similar fashion, with consolidated peak impacts and much lower impacts at the remaining receptors.

The impacts on air quality at the proposed KMC would be minor because impacts for criteria pollutants would be well below the ambient standard. As shown in **Figures 3.1-12** through **3.1-14**, the modeled impacts decrease rapidly with distance from the proposed mining operations.



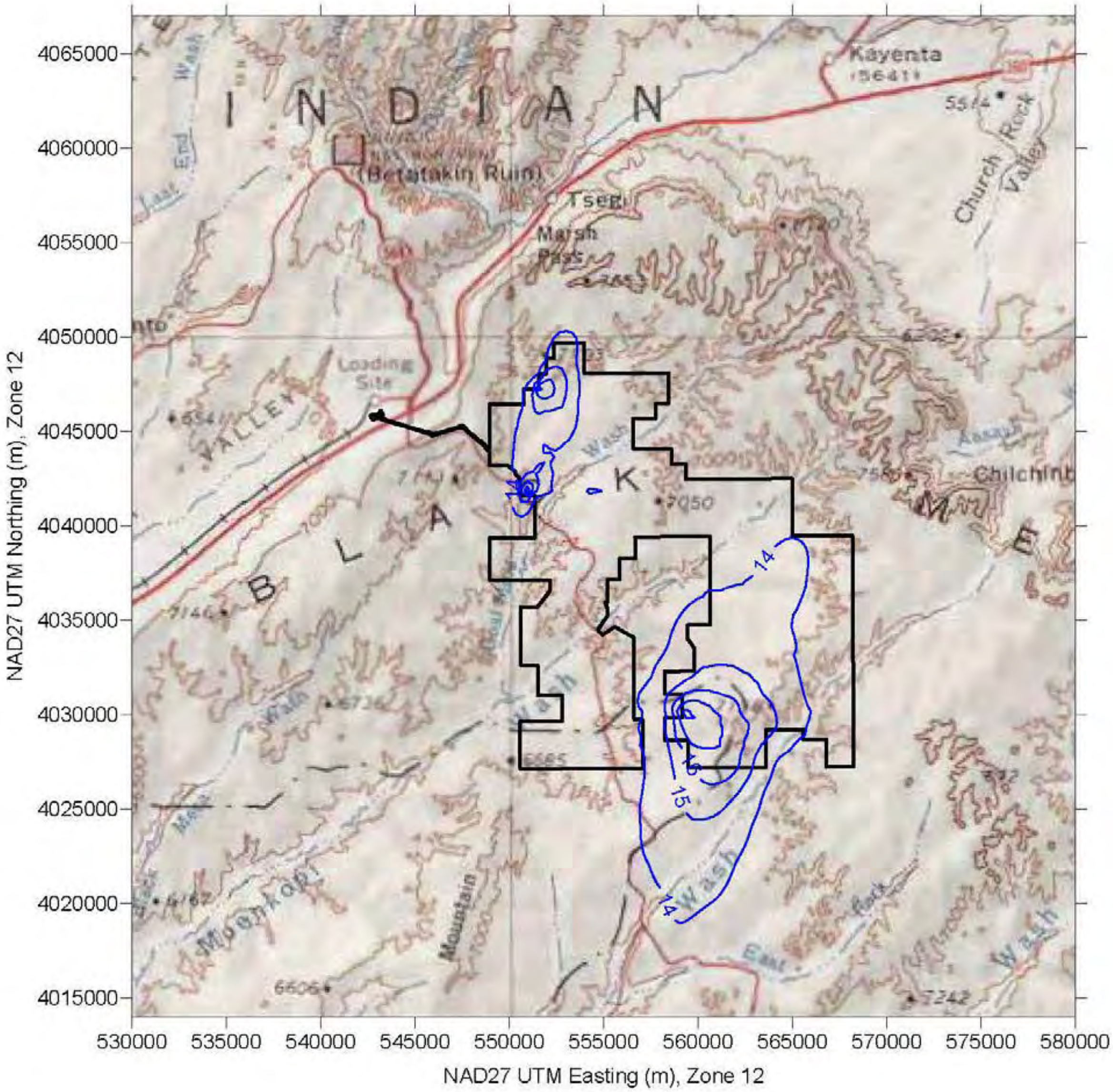
Source: MMA 2016.

Figure 3.1-12 1-hour 5-year Mean 98th Percentile NO_2 Concentration ($\mu g/m^3$) for 8.1 Million tpy Production Operation in 2027



Source: MMA 2016.

Figure 3.1-13 24-hour 6th-High PM_{10} Concentration (µg/m^3) for 8.1 Million tpy Production Operation in 2042



Source: MMA 2016.

Figure 3.1-14 24-hour 5-year Mean 98th Percentile $PM_{2.5}$ Concentration ($\mu g/m^3$) for 8.1 Million tpy Production Operation in 2027

3.1.4.3.2.3 Metals Deposition

The AERMOD modeling system also was used to develop estimates of impacts of trace metals at receptors near the proposed KMC that were identified by the ERAs and HHRAs. Total suspended particulate matter emission sources were divided into two source groups: dirt and coal. The dirt group consists of soil/overburden handling, fugitive dust from traffic along haul roads, and fugitive dust from exposed surfaces. Coal sources consist of pit extraction, coal handling and processing, and coal pile wind erosion. Total suspended particulate and PM_{10} impacts were modeled separately for these two source groups. Airborne particulate matter size distribution data were taken from USEPA (1995). AERMOD generated deposition fluxes on an annual basis. Deposition rates for the trace metals were based on a measured fraction of each trace metal concentration in the soil and coal samples.

Total (both wet and dry) deposition of particulate matter was calculated separately for the two source groups (coal and dirt). The deposition rate of particulate matter was multiplied by the respective 95 percentile upper confidence limit of the trace metals concentrations in soil and in coal (Ramboll Environ 2016e [Table X-1a]) to calculate the annual deposition rate for each metal at each receptor for each of the modeled years. Details of the particulate matter size distribution, the 95 percent upper confidence limit, and the total deposition for each of the modeled years for the 8.1 million tpy production operation and the 5.5 million tpy production operation are provided in MMA (2016 [Section 7.0]). Detailed maximum deposition rates for other chemicals of potential concerns are included in MMA (2016 [Section 7.5]). Average basin-wide deposition rates also were calculated for each of 7 different drainage basins near NGS for mercury and selenium. Details of the deposition rates for each of the identified basins are included in MMA (2016 [Table 8-1]).

Table 3.1-21 provides the maximum deposition rates for the primary chemicals of potential concern at any receptor for any phase of the mining operation.

Table 3.1-21 Deposition Rates for Selected Metals from Proposed KMC Operations

Contaminant	Maximum Deposition Rate at Any Receptor and Any Mining Operation (kg/hectare-year)
Arsenic	0.000489
Mercury (total)	0.0000149
Selenium	0.000131

Source: MMA 2016.

The deposition rates for arsenic, mercury, and selenium can be compared to the baseline concentration in soils by using the 95th percentile upper confidence limit for soil (MMA 2016 [Table 7-1]) and the maximum deposition rate (MMA 2016 [Table 7-3]) and calculating the comparative deposition to the concentration using a 2-centimeter soil depth and 1.5 grams per cubic centimeter density of soil. Using this comparison, over 25 years of operation at the maximum level, arsenic and mercury deposition would add less than 1 percent to the baseline soil concentration. Deposition of selenium would add approximately 23 percent to the baseline soil levels. Similar to the depictions of PM_{10} impacts in MMA (2016 [Figures 6-1 and 6-2]), the highest deposition rates would occur near the proposed mining operations and would be half the maximum deposition rates at all but a few receptors off the mine lease area.

PM_{10} air concentrations for the chemicals of potential concern also were calculated from the modeled coal and dirt source groups by applying the respective upper confidence limit for each contaminant. Diesel particulate matter air concentrations from equipment tailpipes also were modeled. Results of the deposition and air concentration modeling for risk assessment receptors for the 8.1 million tpy and 5.5 million tpy production operations were provided to the ERA and HHRA teams for use in their analyses.

The effect of deposition of chemicals of potential concern from the proposed KMC would be negligible as arsenic and mercury deposition would represent less than 1 percent of the baseline soil concentration. Selenium deposition would have a minor impact as it would reach 23 percent of the baseline soil concentrations after 25 years of operation, but the selenium deposition would occur over a very limited area.

3.1.4.3.2.4 Blasting Operations

Given the intermittent nature of mine blasting, the emissions of NO_X from blasting of coal and overburden were not included in modeling the 1-hour NO_2 concentrations. The on-site monitored NO_2 data from near-pit monitoring sites were analyzed to characterize the impacts of blasting on short-term NO_2 concentrations. The blasting data and 1-hour NO_2 monitored levels were tabulated in cases where the blast occurred within a 90-degree upwind sector of a monitor. The data were analyzed for the hour of the blast as well as the subsequent 2 hours.

For the 3-hour period that included the blast hour and the subsequent 2 hours for all cases where the monitor was within ±45 degrees downwind of the blast, the mean NO_2 concentration was 1.8 ppb. For hours when the monitor was within ±20 degrees, the mean concentration was 2.0 ppb. The highest 1-hour NO_2 concentration recorded downwind of a blast for any hour was 24 ppb (45 $\mu g/m^3$). Therefore, NO_2 produced by blasting events at the proposed KMC likely would not reach the 1-hour NO_2 standard of 188 $\mu g/m^3$.

For 1-hour SO_2 and CO, blasting emissions also were not modeled for the same reasons as 1-hour NO_2. However, on-site monitoring of these pollutants is not necessary due to the small amount of SO_2 emissions and the relatively small amount of CO emissions as compared to the high NAAQS value.

The impact of blasting operations on local air quality would have a negligible effect on hourly NO_2 concentrations because the impacts would be well below the ambient standard, and they would occur intermittently and at different locations under a range of meteorological conditions, thereby limiting the impact at any one receptor.

3.1.4.3.2.5 Visibility

No visibility or plume blight analyses were conducted on proposed KMC operations because the emissions would occur over a broad area and typically would not be a plume. Furthermore, emissions generally would be at or near ground level, thereby impeding their rise into the atmosphere and limiting the spatial extent of their impacts.

3.1.4.3.2.6 Reclamation Activities

Under the Proposed Action the mine areas at the proposed KMC would be subject to reclamation activity to restore the surface to a comparable natural habitat of the area. Exposed coal seam areas would be covered, overburden stockpiles removed or leveled, and a surface covering of natural soils and vegetation would be in place. This activity is defined under the approved reclamation plan and would be similar to the overburden handling activities that are in place for normal operations at the mine (Office of Surface Mining Reclamation and Enforcement 2011). Emissions would be associated with heavy equipment operation engine exhaust and fugitive dust emissions associated with wind erosion and overburden replacement including soil transfers, bulldozing, grading, and topsoil replacement. Emissions during reclamation activities would be less than during active mining. Impacts would be minor because they would be localized and likely well below the ambient air quality standards.

3.1.4.3.3 Transmission Systems and Communication Sites

The transmission lines and communication sites would continue to operate at remote locations from NGS and the proposed KMC. The communication sites include propane-fired generators to provide backup power. Many of the sites are operated and maintained by other users. Given the relatively infrequent testing applied to these facilities, the remote locations, and the relatively low emission rates associated with propane fired units, the air quality emissions and impacts on existing air quality conditions would be negligible. Maintenance activities for the communication sites, transmission lines, and access roads would include vehicle traffic (vehicle exhaust and fugitive dust from unpaved roads), but the maintenance activities would be infrequent, short duration, and/or localized (**Appendix 1B**). For example, transmission line structure maintenance and repair would occur on an as-needed basis; routine actions such as vegetation clearing would occur once every 5 years, or less frequently depending on need; repair of access roads and transmission tower infrastructure would occur along localized sections of the lines or roads; and maintenance of access roads would occur once or twice a year, but equipment would move through the areas quickly. Therefore, emissions for future operations would be considered minor, and environmental impacts would be negligible because these impacts would be infrequent, short duration, and localized.

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

3.1.4.3.4 Project Impact Summary – All Project Components

Air quality impacts from the Proposed Action would be below the ambient air quality standards for all criteria air pollutants, based on the existing background concentrations, projected emission rates, and modeled impacts using USEPA guideline air quality modeling protocols. The maximum impacts would be localized near the major emitting sources, and those impacts would be reduced with increasing distance from those sources.

The maximum impacts on air quality would occur very near the facility operations at both NGS and the proposed KMC. However, those maximum impacts would be reduced to less than half of the ambient air quality standard within a few kilometers of each operating source. The levels of impacts for all project components for each of the considered analyses are provided in **Table 3.1-22**.

Short-term moderate increases in fugitive dust and equipment emissions would occur during decommissioning over a 1-year period at NGS and a minimum 10-year period at the proposed KMC starting in 2044.

Table 3.1-22 Proposed Action Impact Summary

Project Component	Impact Parameter	Impact Magnitude
NGS	Air quality (ambient air quality standards)	Moderate because impacts are close to the standards near NGS but decrease with distance.
	Regional haze	Moderate because impacts are above 1.0 deciviews.
	Acid deposition in Class I areas	Negligible because NGS contributions are a few percent.
	Ozone levels	Minor because NGS contributes up to 2 ppb at locations that are well below the standard.

Table 3.1-22 Proposed Action Impact Summary

Project Component	Impact Parameter	Impact Magnitude
Proposed KMC	Air quality	Minor because impacts are well below the standards.
	Deposition of metals	Negligible for arsenic and mercury deposition which are 1 percent of baseline and minor for selenium as deposition would be up to 23 percent of baseline over 25 years, but over a limited area.
	From blasting operations	Negligible because impacts are well below the standards.
Transmission Systems and Communication Sites	Impacts on air quality and air quality values	Negligible because emissions are small and infrequent.

3.1.4.3.5 Cumulative Impacts

As described in Section 3.1.3, regional air quality is good with no non-attainment areas within 300 km of NGS. There are no reasonably foreseeable new sources of air emissions within the 50-km AERMOD modeling area. Local deposition rates for trace metals (mercury, selenium, and arsenic) were calculated, and background regional and global deposition rates from EPRI (2016) were added to the local deposition rate calculations. Other major emission sources within the 300-km region include coal-fired and natural gas power plants, oil and gas compressor stations and gas processing plants, cement plants, and other industrial sources (**Table 3.1-3** and **Figure 3.1-2**). Emissions from regional urban sources, as well as pollutants transported over long distances (e.g., mercury from China) were included in the monitored background concentrations.

The photochemical grid modeling (CAMx) extended to 300 km from NGS and included numerous existing major sources for the period of the Proposed Action (through 2044). The photochemical grid modeling incorporated foreseeable future year updates of emission estimates from other regional sources, including mobile sources, oil and gas exploration and production, and the major power plants in region. Specific changes in emissions from major sources included the planned reductions in emissions associated with the Regional Haze Rule for affected power plants. Ramboll Environ (2016a [Section 3.3.3]) describes the primary sources and anticipated operational changes within the 2020 to 2044 time frame.

Existing sources are depicted in **Figure 3.1-2** and listed in **Table 3.1-3**. Emissions from other major sources for the period of the Proposed Action were based on the following:

- The shutdown of 2 units at the San Juan Generating Station and installation of SCR on the remaining units from 2020 and beyond.
- The shutdown of 3 units at the Four Corners Power plant and installation of SCR on the remaining units beginning in 2014 and continuing operation with those controls past 2020.
- A USEPA database representing the 2025 emissions inventory used to develop the Particulate Matter Rule for NAAQS (USEPA 2016).

Details of the regional inventories are provided in Ramboll Environ (2016a [Section 3.3.3]).

The cumulative impacts on air quality related to the Proposed Action and the action alternatives are discussed by primary constituent. The effects of all cumulative actions include background air quality concentrations, as well as emissions from other sources. The following discussion focuses on the contribution that the Proposed Action makes to the cumulative impacts from all sources included in the far-field modeling (out to 300 km).

3.1.4.3.5.1 Criteria Pollutants

The modeled concentrations of criteria pollutants (NO_2, CO, SO_2, PM_{10}, $PM_{2.5}$, and lead) at the highest Proposed Action output (i.e. 3-Unit Operation) were in compliance with air quality standards within the 50-km near-field modeling study area. There are no identified existing permitted nearby sources and no reasonably foreseeable new sources within the near-field modeling study area that would affect the highest predicted concentrations near NGS or the proposed KMC.

Table 3.1-23 and **Table 3.1-24** present summaries of the cumulative results at near-field air modeling receptors 50 km and 80 km away from the NGS, respectively (Ramboll Environ2016f). Typically, the near-field modeling techniques used to assess the NAAQS are applied to receptor distances within 50 km. However to support the EIS Human Health Risk Assessment and Ecological Risk Assessment, and to characterize regional impacts, receptors also were considered at 80 km from NGS.

The methods used in the simulations and derivation of background concentrations representative of all other cumulative sources were presented in Ramboll Environ (2016b). The NGS contributions included in **Table 3.1-23** and **Table 3.1-24** are from the simulations of the 3-Unit Operation pre-SCR installation case with the highest emissions, which result in the highest modelled impacts.

The results show that estimated cumulative concentrations are much lower than the NAAQS at 50 km and are even further reduced at 80 km from NGS. Maximum impacts are generally toward the East and East-Northeast of NGS. Concentrations would be reduced further beyond 80 km. Moreover, the near-field modeling results from AERMOD are conservative especially with regard to the 1-hour standards as they reflect worst case meteorological conditions and maximum emission rates. Also, it is very unlikely that peak concentrations from NGS will overlap both in time and space with the peak contributions of other cumulative sources that are farther away and potentially subject to different wind patterns. As shown in **Tables 3.1-23** and **3.1-24**, the highest cumulative impacts are toward the east, in the direction of two other major coal fired power plants, including the Four Corners Power Plant on Navajo Nation lands in New Mexico. In an Environmental Impact Statement for the Four Corners Power Plant (OSMRE 2015, [Table 4.1-41]) cumulative modeled results showed compliance with the ambient air quality standards in the vicinity of that plant.

For the reasons mentioned above, it is highly unlikely that NGS would contribute to cumulative concentrations near the NAAQS at distances beyond 80 km

3.1.4.3.5.2 Deposition

Dispersion and deposition of trace metals from NGS stacks (including mercury, selenium, and arsenic) were assessed in detail for the ERAs (Sections 3.8 through 3.13) and HHRAs (Section 3.16). The NGS contribution to the regional deposition pattern, including cumulative sources, varies by metal. The deposition and fate of mercury has been studied in detail within a region that includes Lake Powell (EPRI 2016). The 3-Unit Operation would contribute between 1.7 and 2.2 percent of the annual deposition from all sources (12.7 micrograms per square meter). At this location, approximately 16 percent of the deposition is from China, approximately 81 percent from the rest of the world, and less than 1 percent from other regional sources within 300 km of NGS. A similar pattern was observed at a receptor point in Lake Powell, where NGS would contribute less than 1 percent of the cumulative deposition.

Table 3.1-23 Cumulative Results from Near-field Modeling for Receptors 50 km from NGS

Pollutant	NAAQS Primary or Secondary Standard (µg/m^3)	Averaging Time	Highest Predicted Conc. due to NGS at 50 km in any Direction (µg/m^3) [1]	Background (µg/m^3)	Cumulative Concentration (µg/m^3)	NGS % of NAAQS	Total Conc. % of NAAQS	Bearing from NGS Plant
NO_2	188	1-hour	***	Varies [2]	112.3	***	60%	ENE
NO_2	100	Annual	1.25	6	7.2	1%	7%	E
CO	40,000	1-hour	84.4	3,664	3,748.4	0%	9%	E
CO	10,000	8-hour	26.8	2,633.5	2,660.3	0%	27%	ENE
SO_2	196	1-hour	50.1	22.5	72.6	26%	37%	E
SO_2	1,310	3-hour	30.4	24.6	55.0	2%	4%	NE
PM_{10}	150	24-hour	1.08	44.5	45.6	1%	30%	E
$PM_{2.5}$	35	24-hour	0.499	20.8 [3]	21.3	1%	61%	E
$PM_{2.5}$	12	Annual	0.0909	5.9 [4]	6.0	1%	50%	E
Lead	0.15	3-month	0.00002	0.01	0.0	0%	7%	E

[1] NGS contributions based on design concentration for the worst year and rank by pollutant and averaging period as follows: SO_2 1-hour: 4th high, SO_2 Annual: 1st high, NO_2 1-hour: 8th high, NO_2 Annual: 1st high, CO 1-hour and 8-hour: 2nd high, PM_{10} 24-hour: 6th high over 5 years, $PM_{2.5}$ 24-hour: 8th high, $PM_{2.5}$ Annual: 1st high, and Lead 3-Month: 1st high.

[2] NO_2 1-hour was modeled in AERMOD with seasonal, hourly background values.

[3] $PM_{2.5}$ 24-hour background includes 1.0 µg/m^3 secondary aerosol formation from CAMx simulation.

[4] $PM_{2.5}$ annual background includes 0.26 µg/m^3 secondary aerosol formation from CAMx simulation.

Table 3.1-24 Cumulative Results from Near-field Modeling for Receptors 80 km from NGS

Pollutant	NAAQS Primary or Secondary Standard ($\mu g/m^3$)	Averaging Time	Highest Predicted Conc. due to NGS at 80 km in any direction ($\mu g/m^3$) [1]	Background ($\mu g/m^3$)	Cumulative Concentration ($\mu g/m^3$)	NGS % of NAAQS	Total Conc. % of NAAQS	Bearing from NGS Plant
NO_2	188	1-hour	***	Varies [2]	76.4	***	41%	E
NO_2	100	Annual	0.655	6	6.7	1%	7%	E
CO	40,000	1-hour	43.8	3,664	3,707.8	0%	9%	E
CO	10,000	8-hour	9.50	2,633.5	2,643.0	0%	26%	E
SO_2	196	1-hour	28.5	22.5	51.0	15%	26%	E
SO_2	1310	3-hour	12.1	24.6	36.7	1%	3%	E
PM_{10}	150	24-hour	0.506	44.5	45.0	0%	30%	E
$PM_{2.5}$	35	24-hour	0.287	20.8 [3]	21.1	1%	60%	E
$PM_{2.5}$	12	Annual	0.0478	5.9 [4]	5.9	0%	50%	E
Lead	0.15	3-Month	0.00001	0.01	0.0	0%	7%	E

[1] NGS contributions based on design concentration for the worst year and rank by pollutant and averaging period as follows: SO_2 1-hour: 4th high, SO_2 Annual: 1st high, NO_2 1-hour: 8th high, NO_2 Annual: 1st high, CO 1-hour and 8-hour: 2nd high, PM_{10} 24-hour: 6th high over 5 years, $PM_{2.5}$ 24-hour: 8th high, $PM_{2.5}$ Annual: 1st high, and Lead 3-Month: 1st high.

[2] NO_2 1-hour was modeled in AERMOD with seasonal, hourly background values.

[3] $PM_{2.5}$ 24-hour background includes 1.0 $\mu g/m^3$ secondary aerosol formation from CAMx simulation.

[4] $PM_{2.5}$ annual background includes 0.26 $\mu g/m^3$ secondary aerosol formation from CAMx simulation.

For arsenic and selenium, NGS is the primary regional air emission source for both metals. Deposition rates decline sharply over a 50-km distance from NGS, with low level concentrations across the Northeast Gap Region that includes Lake Powell and the San Juan River watershed. See Section 3.0 for a discussion of how ecological and human health risk study areas were defined. This pattern is similar to that of the criteria pollutants discussed above. In summary, these metals would not substantially contribute to cumulative impacts with other existing and foreseeable regional emissions sources, as NGS emissions represent only 2 to 9 percent of the total mercury deposition and 0.44 percent of total selenium deposition. Deposition for these metals results primarily from other sources outside of the regional study area.

3.1.4.3.5.3 Regional Haze

Installation of SCR controls as part of the Proposed Action would meet the requirement of the Federal Implementation Plan that was promulgated to improve cumulative visibility impacts in Class I areas, taking into account cumulative impacts from all sources and including stationary industrial sources and other sources such as distant urban emissions, wildfires, and sea salt.

3.1.4.3.5.4 Ozone and Air Quality-related Values

Air quality conditions and impacts beyond the range of the AERMOD modeling analysis were conducted with the photochemical grid model CAMx (Ramboll Environ 2016a). This model evaluated impacts on ozone and acid-deposition within 300 km of NGS, including assessment of visibility impacts at designated Class II locations (Ramboll Environ 2016c). Impacts on acid deposition at Class I areas also were addressed in this modeling effort. The model domain included several Class I areas (National Parks and designated Wilderness Areas) and sensitive Class II areas. The inner grid of receptors for this model, along with the Class I and sensitive Class II areas are depicted in **Figure 3.1-1**.

Details of the CAMx modeling effort, including assumptions, setup, and input data are included in Ramboll Environ (2016c [Section 2.0]). The input meteorological and source characterization data were taken from the 2008 WestJUMP Air Quality Management Study (Environ and Alpine 2012). This is a standard gridded database of the 2008 meteorological database along with emissions data for major sources and area sources embedded for model performance evaluation. Modeled emissions from non-NGS sources included mobile, non-road, area, point, fire, and biogenic emission sources. The model was run for a Base Case using the 2008 data to provide a Model Performance Evaluation, which documented the accuracy of predicted actual ambient concentrations from a database of actual emissions. The same emissions data set was used to develop the regional emissions database for future operations as well, with adjustments for known changes in point source emissions, using the USEPA emission profile for 2020 developed for USEPA modeling of sources to comply with a new ambient standard for $PM_{2.5}$. Emissions from biogenic sources, fires, lightning, sea salt, and fugitive dust sources that contribute to cumulative impacts were unchanged from the 2008 database, along with emissions from Mexico and Canada.

The CAMx model was run using the NGS emissions for the 3-Unit Operation and the 2-Unit Operation, with individual model runs for NGS emissions both prior to and following SCR installation for both options. The model also was designed to run in a source apportionment mode so that any of the impacts could be re-evaluated to determine what source(s) contribute the largest portion to any impact.

3.1.4.3.5.5 Impacts on Ozone Levels

The CAMx model produced a spatial depiction of impacts on ozone levels in the region, for both the pre-SCR and post-SCR operations. The spatial pattern was developed using the USEPA Modeled Attainment Test Software (Abt 2009; USEPA 2015b). The largest impacts were associated with the 3-Unit Operation from emissions prior to the installation of SCR on NGS. The results show isolated areas of slightly elevated high ozone levels, but overall compliance with the ambient standard level. Prior to the installation of SCR, the NGS contribution to the design value above 1 ppb would be limited to an area to the east and north of the facility, with a maximum ozone design value contribution of 2.3 ppb. Following installation of SCR, the nearby impact on ozone levels would be reduced to a maximum receptor impact of 1.6 ppb. For the 2-Unit Operation the impacts would be reduced from the 3-Unit Operation impacts with a maximum of 2.1 ppb prior to the installation of SCR and 1.3 ppb following installation of SCR. Compared to the impacts from the 3-Unit Operation, the extent of the area where NGS impact would be above 1 ppb would be reduced for both the 2-Unit Operation and for installation of SCR on both 3-Unit Operation and 2-Unit Operation.

The cumulative ozone design value impacts would be 76 ppb (i.e., above 70 ppb standard) in southern Coconino County, in Maricopa County, and at receptors in Southern Apache County; however, the contribution from NGS to the ozone levels at these locations would be 0.0 to 0.4 percent of the total ozone levels.

The future operation of NGS under the Proposed Action would not cause an exceedance of the ambient air quality standard within the 50-km near-field study area for ozone. Isolated areas within the regional 300-km study area would experience major impacts from ozone, where ozone concentrations would exceed the NAAQS. However, NGS would provide a negligible contribution to these exceedances, representing only up to 0.4 percent of the total. Cumulative impacts on ozone levels would be considered major because there are several locations in the study area where those impacts would be above the ambient standard; however, those impacts would result from emissions from other sources.

3.1.4.3.5.6 Ozone Impacts at Class I and Identified Sensitive Class II Areas

Model results for a range of predicted maximum design value ozone impacts for each of the identified Class I areas are provided in **Table 3.1-25**. The table provides the No Action Alternative impact for comparison to the range of impacts from the Proposed Action. In this case, the NGS 3-Unit Operation for 2020 prior to installation of the SCR would result in the maximum NGS impact contribution, and the NGS 2-Unit Operation following installation of SCR would result in the lowest impact contribution. NGS 3-Unit Operation or 2-Unit Operation, both prior to and following SCR installation, would result in negligible effects on ozone levels. The highest impacts would be at Grand Canyon National Park, where NGS impact contributions would range from 0.4 to 0.5 ppb. At most of the other Class I areas, impacts would be between 0.0 and 0.3 ppb, with even less of a difference between the 3-Unit Operation and 2-Unit Operation, including pre- and post-SCR installation. In demonstrating compliance with the 8-hour ozone standard, the 3-year average of the annual fourth highest daily values in ppm is expressed to three decimal places (or whole ppb values). For example a calculated average of 70.9 ppb (0.0709 ppm) would be shown as 70 ppb (0.070 ppm) and therefore would be compliant with the standard (40 CFR 50 Appendix U paragraph 3(e)). None of the predicted concentrations in **Table 3.1-25** would be above the ambient standard because the data are truncated to 3 decimal places in ppm (or whole ppb).

Table 3.1-25 Range of Maximum Ozone Impacts of NGS Operation at Class I Areas

		Ozone Concentration (ppb)			
		2020 3-Unit Operation Pre-SCR Installation		2030 2-Unit Operation Post-SCR Installation	
Class I Area	No Action	Cumulative	NGS Only	Cumulative	NGS Only
Arches National Park	69.6	69.7	0.1	69.7	0.1
Bryce Canyon National Park	68.2	68.1	-0.1	68.2	0.0
Canyonlands National Park	70.1	70.2	0.1	70.1	0.0
Capitol Reef National Park	68.5	68.8	0.3	68.7	0.2
Grand Canyon National Park	70.0	70.5	0.5	70.2	0.2
Mazatzal Wilderness Area	66.1	66.2	0.1	66.1	0.0
Mesa Verde National Park	68.6	68.6	0.0	68.6	0.0

Table 3.1-25 Range of Maximum Ozone Impacts of NGS Operation at Class I Areas

Class I Area	No Action	Ozone Concentration (ppb)			
		2020 3-Unit Operation Pre-SCR Installation		2030 2-Unit Operation Post-SCR Installation	
		Cumulative	NGS Only	Cumulative	NGS Only
Petrified Forest National Park	64.8	64.9	0.1	64.9	0.1
Pine Mountain Wilderness Area	63.5	63.6	0.1	63.5	0.0
Sycamore Canyon Wilderness Area	67.1	67.3	0.2	67.3	0.2
Zion National Park	68.3	68.6	0.3	68.4	0.1

Source: Ramboll Environ 2016a.

Model results for the range of predicted ozone levels for each of the identified sensitive Class II areas are provided in **Table 3.1-26.** Similar to the results for Class I areas, the table provides the No Action Alternative impact for comparison to the range of impacts from the Proposed Action. The NGS 3-Unit Operation or 2-Unit Operation, prior to and following SCR installation, would result in negligible effect on maximum ozone levels at these areas. The largest NGS impacts would be at the Pine Valley Mountain Wilderness Area and Wupatki National Monument, where NGS would contribute 0.3 ppb for the 3-Unit Operation prior to SCR installation, and 0.1 ppb for the 2-Unit Operation after SCR installation. The maximum contribution for 2030 with the 2-Unit Operation at any site would be 0.1 ppb.

Table 3.1-26 Range of Maximum Ozone Impacts of NGS Operation at Sensitive Class II Areas

Sensitive Class II Area	No Action	Ozone Concentration (ppb)			
		2020 3-Unit Operation Pre-SCR Installation		2030 2-Unit Operation Post-SCR Installation	
		Cumulative	NGS Only	Cumulative	NGS Only
Ashdown George Wilderness	69.6	69.6	0.0	69.6	0.0
Box-Death Hollow Wilderness	69.1	69.2	0.1	69.1	0.0
Canyon DeChelly National Monument	67.7	67.9	0.2	67.8	0.1
Chaco Culture National Historic Park	65.1	65.1	0.0	65.1	0.0
Cottonwood Forest Wilderness	66.8	67.0	0.2	66.9	0.1
Dark Canyon Wilderness	69.3	69.4	0.1	69.3	0.0
Glen Canyon National Recreation Area	70.0	70.1	0.1	70.0	0.0
Natural Bridges National Monument	68.4	68.5	0.1	68.5	0.1
Pine Valley Mountain Wilderness	67.0	67.3	0.3	67.1	0.1
Wupatki National Monument	67.5	67.8	0.3	67.6	0.1

Source: Ramboll Environ 2016a.

Ozone levels would be in compliance with the ambient air quality standard at all sensitive Class II areas and Class I areas. The maximum impacts associated with the 3-Unit Operation prior to installation of SCR at Grand Canyon National Park would comply with, but would be just less than, the NAAQS at Grand Canyon National Park, representing a moderate cumulative impact. However, NGS would represent less than 1 percent of the total cumulative impact. Impacts from the 2-Unit Operation would be equivalent or slightly less than the impacts from the 3-Unit Operation. In general the impacts of the

Proposed Action on ozone levels would be minor because they would be within the typical range of variability in the study area.

3.1.4.3.5.7 Acid Deposition

Emissions of SO_2 and NO_X are converted by atmospheric processes to ground-level deposition of acidic sulfur and nitrogen compounds, both through wet deposition during precipitation events and dry deposition occurring as particles that are deposited on the earth and water surfaces. Wet and dry deposition of sulfur and nitrogen containing compounds were evaluated with the CAMx model throughout the modeling domain, and included specific analyses at Class I areas and sensitive Class II areas.

In the vicinity of NGS (i.e., within 50 km), total sulfur deposition would be up to 3 kg/hectare-year for the 3-Unit Operation prior to and after installation of SCR. Similar patterns would occur for the 2-Unit Operation but with slightly less deposition for both sulfur and nitrogen. Maximum total nitrogen deposition would be approximately 1 to 4 kg/hectare-year for the 3-Unit Operation, and the footprint would be reduced following installation of SCR because of the reduced emission rate of NO_X from the main stacks. Total sulfur deposition could increase slightly following installation of SCR because the ammonia slip from SCR operation would react with SO_2 to produce a sulfate compound, which enhances deposition of total sulfur.

Total annual average sulfur deposition also was calculated at receptors in selected nearby Class I areas for the 3-Unit Operation both before and after SCR installation. Arches National Park has the lowest cumulative total annual average deposition rate of all listed areas, averaging 0.24 kg/hectare-year for the 3-Unit Operation. The highest cumulative modeled deposition rate was at the Pine Mountain Wilderness Area with average deposition of 0.70 kg/hectare-year. The NGS average contribution to deposition would be greatest at Bryce Canyon National Park with 0.03 kg/hectare-year for those receptors for the 3-Unit Operation. The modeled deposition rate at the maximum impact receptor at Bryce Canyon National Park was 0.037 kg/hectare-year.

Total modeled cumulative annual average deposition rates of nitrogen compounds in the Class I Areas ranged from 1.64 kg/hectare-year at Canyonlands National Park to 3.64 kg/hectare-year at the Mazatzal Wilderness Area. The maximum impact from NGS operations would occur at Capitol Reef National Park at 0.06 and 0.02 kg/hectare-year for pre- and post-SCR installation, respectively. The analyses clearly indicate that the NGS contribution to either sulfur or nitrogen deposition at the Class I areas would be about 3 percent or less of the No Action cumulative deposition rate at Bryce Canyon National Park and other nearby Class I areas, and much less than that at more distant Class I areas. A slight reduction in average impacts at Class I areas nearest to NGS would occur following the installation of SCR, with a greater reduction seen for nitrogen deposition than for sulfur deposition.

The deposition rates also were evaluated at 59 separate lakes and streams in Arizona, Colorado, and Utah. An analysis of the critical load of acidity for sulfur and nitrogen was prepared. Cumulative acid deposition exceeded the critical load at only one waterbody, the Anasazi Pond near Spillway, Utah (which was 0.45 kg/hectare-year for sulfur deposition and 2.17 kg/hectare-year for nitrogen deposition). This would be a major cumulative impact at this one location, but NGS contribution would be negligible at approximately 2 to 3 percent of the total cumulative deposition. For all other waterbodies, the nitrogen and sulfur deposition were below the critical load, and the contribution from NGS generally would be approximately 0.1 percent of the critical load, with some deposition rates from NGS of approximately 1 to 2 percent of the critical load. As a result, the Proposed Action would have a negligible impact on acidic deposition at these locations.

A total of 111,307 forest data locations were examined for nitrogen and sulfur acid deposition compared to critical loads of acidity. Exceedances of critical load from cumulative impacts were noted at 9 of the sites, which were all in the Upper Gila Mountains. The contribution from NGS and the proposed KMC was approximately 0.3 percent of the total for the 3-Unit Operation and 0.2 percent of the total for the 2-Unit Operation.

Empirical critical loads for nitrogen deposition at 11 Class I areas were obtained from Pardo et al. (2011) and the National Atmospheric Deposition Program CLAD database (National Atmospheric Deposition Program 2015b). Following Ellis et al. (2013), the critical loads for the most sensitive ecosystem receptor were identified in the North American Deserts ecoregion. The critical load for lichens and lower critical load for herbaceous species and shrubs were evaluated at the 11 Class I areas, both for cumulative impacts and for the contribution from the Proposed Action. The maximum cumulative nitrogen deposition exceeded the critical loads for lichens and the lower critical load for herbaceous species (3 kg/hectare-year) at 7 of the 11 areas and was as high as 5.5 kg/hectare-year at Zion National Park. These would be considered major cumulative impacts. The contribution from the Proposed Action at these areas ranged from 0.4 to 3.2 percent for the 3-Unit Operation and from 0.2 to 2.5 percent for the 2-Unit Operation prior to the installation of SCR; therefore, the NGS contribution to the cumulative impact would be negligible. Impacts of nitrogen deposition would be further reduced with the installation of SCR for both operations and would be considered negligible.

Impacts of nitrogen and sulfur deposition from NGS operations would be largest near (within 10 km) NGS and decrease with distance from the facility. Proposed Action impacts from deposition of these compounds on the Class I areas and the identified Class II areas would range from negligible to a few percent of the total deposition rates for both species. Nitrogen impacts from NGS operations following the installation of SCR would be reduced proportionally to the reduction in NO_X emissions and would remain negligible.

There are no major permitted air quality sources near the proposed KMC; therefore, there would be no overlapping or spatially cumulative impacts. Air quality emissions and impacts would be directly related in time and would not accumulate except for deposition of trace metals and other particulate matter. The deposition rates and impacts are discussed further for the ERAs and HHRAs.

3.1.4.3.5.8 Transmission Systems and Communication Sites

Emissions of criteria pollutants associated with small transmission line maintenance crews would widely dispersed in space and time. It is estimated that approximately 100 pounds of criteria pollutants and three tons of CO_2 equivalent would be emitted by light duty vehicles driving 2,000 miles annually. The Western Transmission System maintenance activities would overlap with construction of transmission lines and pipelines in the same utility corridor and access roads in northern Arizona and southern Nevada. This would result in short-term (months) local increases in criteria pollutant and greenhouse gas emissions from diesel and gasoline internal combustion engines where project activities overlap. There are no foreseen overlapping projects associated with the Southern Transmission System.

Because there are no foreseeable actions that would intersect the communication sites within the geographic space and time frame of the Proposed Action, there would be no cumulative impacts to air quality.

3.1.4.3.5.9 Cumulative Impacts Summary

The magnitude of cumulative impacts for each of the considered analyses are provided below and represent the maximum cumulative impact levels in the study area, along with the contribution from the Proposed Action. Project contributions to regional cumulative impacts would be negligible (generally less than 1 percent) at the local scale. NGS emissions would not interact with any other nearby large fossil-fuel source. At a regional scale, cumulative impacts would be major for ozone and regional haze when all sources are considered. Cumulative impacts for acid deposition would be moderate to major.

Air Quality Impacts	Moderate based on the maximum impacts around NGS but minor elsewhere in the study area, based on levels well below the ambient standard as shown in **Table 3.1-4**.
Regional Haze	Moderate, given the impacts would remain above 1.0 deciviews following installation of SCR.
Acid Deposition	Moderate given that cumulative deposition would exceed 3 kg/hectare-year at 4 of the Class I areas, but would be below 8 kg/hectare-year at all Class I areas. NGS contribution is less than 1 percent at these locations and would be negligible. Acid deposition at forest locations would be minor; well below the critical load except at 9 out of 111,307 sites and at one of 59 lakes and streams. However, the cumulative impacts at some locations would be major because the critical load for nitrogen would be exceeded at 7 of the 11 Class I sites, and the critical load for sulfur and nitrogen would be exceeded at one of 59 lakes and streams.
Ozone Levels	Major for cumulative impacts due to the predicted exceedances of the standard at locations in the study area; however, NGS contribution at those receptors would be negligible.

3.1.4.4 Natural Gas Partial Federal Replacement Alternative

3.1.4.4.1 Navajo Generating Station

Under the Natural Gas PFR Alternative, a selected quantity of power between 100 megawatts (MW) and 250 MW would be contracted for under a long-term power purchase agreement from currently unidentified, existing natural gas generation sources, displacing an equivalent amount of power from the federal share of NGS generation. For this replacement power, the total emissions from the natural gas-fired unit were estimated from a permit analysis for the Bowie Power Plant in Arizona (Arizona Department of Environmental Quality 2014). That facility is a 1,050-MW (nominal) natural gas-fired, combined cycle power plant.

Table 3.1-27 provides a comprehensive air quality overview of the Natural Gas PFR Alternative, including total emissions from NGS and the replacement facility for criteria air pollutants and selected HAPs. The impacts provided in **Table 3.1-27** include only the impacts from NGS added to background concentrations for criteria air pollutants and do not include impacts for the replacement facility because they would not overlap under this alternative. Arizona Department of Environmental Quality (2014) determined that all air quality impacts (except for the 1-hour NO_2 impact) from the Bowie Power Plant were below the established impact limit for major source permitting under federal rules (40 CFR Part 52.21). The scaled 1-hour NO_2 impact for 100 MW of power would be approximately 11.2 $\mu g/m^3$, which is approximately 6 percent of the ambient standard. Unless the replacement power would be provided by a source that is near another major source, that impact likely would be minor and localized. Therefore, impacts from a replacement facility were not analyzed further for this alternative.

The maximum impacts at NGS are dominated by surface level operations (e.g., mobile heavy equipment, coal and ash handling systems); therefore, there would be no difference in impacts for the range of power generation with the exception of SO_2, which is dominated by the emissions from the main stacks. There also would be little difference in maximum impacts when compared to the range of impacts associated with the Proposed Action. The impacts on ozone levels, acid deposition in Class I areas, and plume visibility at the maximum impacted vista would represent NGS impacts only. The NGS impacts shown in **Table 3.1-27** are conservative because they generally represent the modeled maximum impact across pre-SCR and post-SCR conditions.

Table 3.1-27 Emissions and Impacts from NGS Associated with the Natural Gas PFR Alternative

Parameter		Emissions / Impacts			
		3-Unit Operation		2-Unit Operation	
		100-MW Replacement	250-MW Replacement	100-MW Replacement	250-MW Replacement
(NGS Main Stack plus Natural Gas Replacement Emissions of Criteria Pollutants and Selected HAP Metals (tons/year)					
Pre-SCR NO_X		19,461	18,039	12,658	11,236
Post-SCR NO_X		6,542	6,151	4,274	3,883
CO		14,056	13,274	9,197	8,415
SO_2		9,231	8,500	5,992	5,260
PM_{10}		1,972	1,826	1,282	1,136
$PM_{2.5}$		1,419	1,317	932	821
VOC		233	216	152	135
Arsenic		0.127	0.117	0.083	0.073
Mercury		0.111	0.102	0.072	0.063
Selenium		2.127	1.957	1.377	1.208
NH_3 Pre-SCR		0	0	0	0
NH_3 Post-SCR		42	38	27	24
H_2SO_4 Pre-SCR		45	41	29	25
H_2SO_4 Post-SCR		366	336	204	179
NGS Support Facility Emissions (tons/year)					
NO_X		56	52	46	41
CO		22	20	19	19
SO_2		1	1	1	1
PM_{10}		97	89	86	74
$PM_{2.5}$		14	13	13	11
VOC		6	5	5	4
Maximum Short-term Impacts ($\mu g/m^3$) and Air Quality Standards (shaded)					
1-hour NO_2	188	186.3	186.3	186.3	186.3
1-hour CO	40,000	4,402.8	4,402.8	4,402.8	4,402.8
1-hour SO_2	196	156.7	146.3	111.0	100.6
3-hour SO_2	1,300	101.9	95.7	74.6	68.4
24-hour PM_{10}	150	138.6	138.4	137.5	137.3
24-hour $PM_{2.5}$	35	32.7	32.7	32.6	32.6
8-hour ozone (ppb)	70	2.3	2.2	2.1	2.0

Table 3.1-27 Emissions and Impacts from NGS Associated with the Natural Gas PFR Alternative

Parameter		Emissions / Impacts			
		3-Unit Operation		2-Unit Operation	
		100-MW Replacement	250-MW Replacement	100-MW Replacement	250-MW Replacement
Maximum Annual Average Impacts (µg/m^3) and Air Quality Standards (shaded)					
Pre-SCR NO_2	100	20.1	19.5	17.8	17.2
Post-SCR NO_2	100	18.1	17.7	16.6	16.2
$PM_{2.5}$	12	7.6	7.5	7.4	7.3
Maximum Acid Deposition Rate (kg/hectare-year)					
Sulfur Deposition		0.035	0.032	0.023	0.020
Nitrogen Deposition		0.057	0.053	0.038	0.034

Shaded numbers represent the NAAQS.

Annual power production from NGS would be reduced by 100 MW to 250 MW, resulting in a reduction in power generation at NGS ranging from of 5 to 13 percent for the 3-Unit Operation and 8 to 19 percent for the 2-Unit Operation (**Table 3.0-4**). This reduction would be applied to the annual emissions of pollutants from the main stacks; however, maximum daily emissions under this alternative could be the same as the Proposed Action for the 3-Unit Operation and 2-Unit Operation because there would be no associated restriction on a daily basis. The maximum short-term (daily and hourly) impacts for all pollutants (except SO_2) near the NGS ambient air quality boundary would be roughly the same for the 3-Unit Operation and 2-Unit Operation because the emissions are dominated by surface level operations and would be just below the ambient standards (except that CO impacts would be well below the standards). For SO_2 impacts, the daily and 1-hour maximum impacts could be the same as the individual 3-Unit Operation and 2-Unit Operation given that the hourly operations would not be restricted by the Natural Gas PFR Alternative. Maximum annual impacts for the Natural Gas PFR Alternative for NO_2 prior to installation of SCR would be reduced by a range of approximately 1.5 to 5 percent. (See **Tables 3.1-12** and **3.1-13** for the Proposed Action values.) Annual impacts on $PM_{2.5}$ levels would be roughly identical for the 3-Unit Operation and 2-Unit Operation and would be just below the ambient standards. Impacts from NGS on air quality for this alternative would be considered moderate because of high impacts locally near the facility.

3.1.4.4.2 Proposed Kayenta Mine Complex

Under the Natural Gas PFR Alternative, mining operations at the proposed KMC would be reduced relative to the power generation reductions at NGS (**Table 3.0-6**). The environmental consequences of the Natural Gas PFR Alternative at the proposed KMC would be related to annual and daily coal production. Although the PFR alternatives were not specifically analyzed for air emissions or modeled for impacts to air quality, an estimate of those emissions and impacts was calculated based on the change in total coal production for each alternative. The impacts would be reduced from the 3-Unit Operation impacts based on the ratio of the reduced coal production to the difference in coal production for the 3-UnitOperation and 2-Unit Operation. Similar to the analysis for NGS, the range of impacts from the Natural Gas PFR Alternative would correspond to the reduction of 100-MW to 250-MW energy production at NGS. Emissions or impacts for the Natural Gas PFR at the proposed KMC do not include emissions or impacts from the replacement source of power, as the facility associated with the replacement would be negligible for all pollutants as discussed for NGS. Additionally, the replacement facility likely would be far away from the proposed KMC. **Table 3.1-28** provides a summary of annual and daily emissions and impacts associated with the Natural Gas PFR. Maximum impacts are provided separately for receptors off the proposed KMC lease area and for residence receptors on the proposed KMC lease area. All data are based on the maximum impact at any of the group receptors. Impacts would be well below the NAAQS and considered minor.

Table 3.1-28 Emissions and Impacts of the Proposed KMC Operations Associated with the Natural Gas PFR Alternative

Parameter		Emissions / Impacts			
		3-Unit Operation		2-Unit Operation	
		100-MW Replacement	250-MW Replacement	100-MW Replacement	250-MW Replacement
KMC Emissions of Criteria Pollutants (ton/year)					
NO_X		588	542	392	344
CO		506	463	324	280
SO_2		1	1	1	1
PM_{10}		682	667	619	604
$PM_{2.5}$		100	98	93	91
KMC Emissions of Criteria Pollutants (pounds per day)					
NO_X		28,257	27,753	26,118	25,606
CO		84,894	84,929	85,044	85,080
SO_2		23	22	19	18
PM_{10}		7,621	7,205	5,855	5,431
$PM_{2.5}$		1,128	1,072	890	833
Maximum Impact at Off-site Receptors (µg/m^3) and Air Quality Standards (shaded)					
1-hour NO_2	188	144.3	140.7	128.9	125.3
Annual NO_2	100	14.1	13.6	12.0	11.5
1-hour CO	40,000	2,020.6	2,020.4	2,019.5	2,019.3
8-hour CO	10,000	4,978.8	4,922.4	4,739.3	4,681.9
1-hour SO_2	196	23.4	23.3	23.1	23.0
3-hour SO_2	1,300	20.6	20.5	20.0	19.9
24-hour PM_{10}	150	100.2	95.7	81.4	76.9
24-hour $PM_{2.5}$	35	18.9	19.1	20.0	20.2
Annual $PM_{2.5}$	12	5.9	5.9	6.0	6.0
Maximum Impact at Residence Receptors (µg/m^3) and Air Quality Standards (shaded)					
1-hour NO_2	188	123.7	121.1	112.5	109.8
Annual NO_2	100	13.0	12.4	10.5	9.9
1-hour CO	40,000	1,979.5	1,982.4	1,991.9	1,994.9
8-hour CO	10,000	2,830.3	2,908.9	3,164.3	3,244.4
1-hour SO_2	196	23.0	23.0	22.9	22.9
3-hour SO_2	1,300	19.6	19.6	19.7	19.7
24-hour PM_{10}	150	67.5	66.1	61.4	60.0
24-hour $PM_{2.5}$	35	16.9	16.8	16.3	16.2
Annual $PM_{2.5}$	12	5.7	5.6	5.5	5.4

Shaded numbers represent the NAAQS.

3.1.4.4.3 Transmission System and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance. Emissions and impacts would be the same as under the Proposed Action.

3.1.4.4.4 Project Impact Summary – All Project Components

Although the emissions from NGS operations would lead to slight impacts near the proposed KMC operations, the maximum impacts for each operation would not be affected by those emissions. Therefore, the combined maximum impacts from all project components for the Natural Gas PFR Alternative would be based on the maximum impacts individually at NGS and the proposed KMC. More specifically the maximum impacts at NGS and the proposed KMC would not be substantially affected by the overlap between the two operations. The impacts from the proposed KMC on receptors near NGS would be negligible in comparison to the direct impacts from NGS. Similarly the impacts of NGS on the proposed KMC operations would be much smaller than the impacts directly around NGS; however, an effort was made to add impacts from NGS main stack emissions to the background concentration used in estimating impacts at the proposed KMC. The emissions from the Natural Gas PFR Alternative would be considered moderate for NGS and minor for the proposed KMC, similar to the Proposed Action.

3.1.4.4.5 Cumulative Impacts

Cumulative impacts resulting from the Natural Gas PFR Alternative would be reflected in the impacts for NGS and the proposed KMC as provided above. The dispersion modeling analysis included background air quality concentrations for analyzing compliance with the NAAQS, and the combination of the modeled source impacts added to the background would represent the cumulative impacts for all sources. Impacts from the replacement facility would occur at a separate location near that facility and would be negligible (as noted above) except potentially for 1-hour NO_2 impacts. Without detailed information about the site, topography, stack and source parameters, and background concentration, the impact on 1-hour NO_2 levels cannot be characterized.

Maximum cumulative impacts on ozone levels in the study area would occur at a location in southern Coconino County, near Flagstaff, Arizona. That design-value impact is approximately 76 ppb for both the 3-Unit Operation and 2-Unit Operation, with a reduction calculated to be 0.1 ppb following the installation of SCR at NGS. Given that the maximum impact would not change for the 3-Unit Operation and 2-Unit Operation, there would be no detectable impact on cumulative maximum ozone levels for the Natural Gas PFR Alternative.

The maximum cumulative sulfur deposition would be in southern Apache County in Arizona, with a deposition rate of 21.2 kg sulfur/hectare-year for the 3-Unit Operation. The maximum cumulative nitrogen deposition would occur in northwestern McKinley County in New Mexico, near the Arizona border. The total nitrogen deposition rate would be approximately 30.5 kg nitrogen/hectare-year at that location. The selection of this Natural Gas PFR Alternative would not have an effect on the maximum cumulative acid deposition levels because of the negligible (less than 1 percent) contribution of NGS to total deposition at these locations.

3.1.4.5 Renewable Partial Federal Replacement Alternative

3.1.4.5.1 Navajo Generating Station

Under the Renewable PFR Alternative, a selected quantity of power between 100 MW and 250 MW would be contracted for under a long-term power purchase agreement from a currently unidentified, existing renewable energy power source, displacing an equivalent amount of power from the federal share of NGS generation. The Renewable PFR Alternative assumes that this installation would require firming power generation and those emissions are included in **Table 3.1-29**. See Section 2.2.3 for details regarding firming power.

Table 3.1-29 Emissions and Impacts from NGS Associated with the Renewable PFR Alternative

Parameter		Emissions / Impacts			
		3-Unit Operation		2-Unit Operation	
		100-MW Replacement	250-MW Replacement	100-MW Replacement	250-MW Replacement
NGS Main Stack plus Natural Gas Firm Power Emissions of Criteria Pollutants and Selected HAP Metals (tons/year)					
Pre-SCR NO_X		19,811	18,914	13,008	12,111
Post-SCR NO_X		6,606	6,310	4,338	4,042
CO		14,156	13,524	9,297	8,665
SO_2		9,433	9,004	6,193	5,764
PM_{10}		2,009	1,918	1,319	1,229
$PM_{2.5}$		1,443	1,378	947	882
VOC		237	226	156	145
Arsenic		0.130	0.124	0.086	0.080
Mercury		0.114	0.108	0.075	0.069
Selenium		2.174	2.075	1.424	1.325
NH_3 Pre-SCR		0	0	0	0
NH_3 Post-SCR		43	41	28	26
H_2SO_4 Pre-SCR		46	44	30	28
H_2SO_4 Post-SCR		374	357	211	197
NGS Support Facility Emissions (tons/year)					
NO_X		57	55	48	44
CO		22	21	23	21
SO_2		1	1	1	1
PM_{10}		99	94	89	83
$PM_{2.5}$		14	14	13	12
VOC		6	6	5	4
Maximum Short-term Impacts (μg/m^3) and Air Quality Standards (shaded)					
1-hour NO_2	188	186.3	186.3	186.3	186.3
1-hour CO	40,000	4,402.8	4,402.8	4,402.8	4,402.8
1-hour SO_2	196	159.6	153.5	113.9	107.8
3-hour SO_2	1,300	103.6	100.0	76.3	72.7
24-hour PM_{10}	150	138.7	138.6	137.6	137.5
24-hour $PM_{2.5}$	35	32.7	32.7	32.6	32.6

Table 3.1-29 Emissions and Impacts from NGS Associated with the Renewable PFR Alternative

Parameter		Emissions / Impacts			
		3-Unit Operation		2-Unit Operation	
		100-MW Replacement	250-MW Replacement	100-MW Replacement	250-MW Replacement
8-hour Ozone (ppb)	70	2.3	2.3	2.1	2.1
Maximum Annual Average Impacts (µg/m^3) and Air Quality Standards (shaded)					
Pre-SCR NO_2	100	20.2	19.9	17.9	17.6
Post-SCR NO_2	100	18.2	18.0	16.7	16.5
$PM_{2.5}$	12	7.6	7.6	7.4	7.4
Sulfur Deposition		0.036	0.034	0.024	0.022
Nitrogen Deposition		0.058	0.056	0.039	0.037

Shaded numbers represent the NAAQS.

The maximum air quality impacts are provided in **Table 3.1-29**, but include only the impacts from NGS added to the background concentrations for the criteria air pollutants. Except for SO_2, the maximum impacts at NGS would be generated by surface level operations (e.g., mobile heavy equipment, coal and ash handling systems). As a result, there would be is no reduction in impacts from these emissions for the range of power generation when compared to the range of impacts associated with the Proposed Action. The maximum impacts from NGS on ozone levels, acid deposition in Class I areas, and plume visibility at the maximum impacts vista are shown for NGS impacts only.

Annual power production from NGS would be reduced on an average basis, resulting in a reduction in power generation at NGS in a range of 3 to 7 percent for the 3-Unit Operation and 4 to 11 percent for the 2-Unit Operation (**Table 3.0-4**). This reduction could be applied to the annual emissions of pollutants from the main stacks; however, maximum daily emissions under this alternative could be the same as the Proposed Action for the 3-Unit Operation and 2-Unit Operation because there would be no associated restriction on a daily basis. The maximum short-term (daily and hourly) impacts for all pollutants (except SO_2) near the NGS ambient air quality boundary would be roughly the same for the 3-Unit Operation and 2-Unit Operation because the emissions are dominated by surface level operations and would be just below the ambient standards. For SO_2 impacts, the daily and 1-hour maximum impacts could remain the same as the individual 3-Unit Operation and 2-Unit Operation because hourly operations would not be restricted by the Renewable PFR Alternative. Annual maximum impacts for the Renewable PFR Alternative for NO_2 prior to installation of SCR would be reduced by a range of approximately 1 to 3 percent. (See **Tables 3.1-12** and **3.1-13** for the Proposed Action values.) Annual impacts on $PM_{2.5}$ levels would be roughly identical for the 3-Unit Operation and 2-Unit Operation and would be just below the ambient standards. Impacts from NGS on air quality for this alternative would be considered moderate because of high impacts locally near the facility.

3.1.4.5.2 Proposed Kayenta Mine Complex

Under the Renewable PFR Alternative, mining operations at the proposed KMC would be reduced relative to the power generation reduction at NGS (**Table 3.0-6**). The environmental consequences of the Renewable PFR Alternative at the proposed KMC would be related to annual and daily coal production. Although of the PFR alternatives were not specifically analyzed for air emissions or modeled for impacts to air quality, an estimate of those emissions and impacts was calculated based on the change in total coal production for each alternative. The method for estimating emissions and impacts for the Renewable PFR Alternative was identical to those used for the Natural Gas PFR Alternative. **Table 3.1-30** provides a summary of annual and daily emissions and impacts associated with the Renewable PFR Alternative. Maximum impacts are provided separately for receptors off the proposed KMC lease area and for residence receptors on the proposed KMC lease area. All data are based on the maximum impact at any of the group receptors. Impacts would be well below the NAAQS and considered minor.

Table 3.1-30 Emissions and Impacts of the Proposed KMC Operations Associated with the Renewable PFR Alternative

Parameter		Emissions / Impacts			
		3-Unit Operation		2-Unit Operation	
		100-MW Replacement	250-MW Replacement	100-MW Replacement	250-MW Replacement
Proposed KMC Emissions of Criteria Pollutants (ton/year)					
NO_X		601	574	405	377
CO		518	493	336	311
SO_2		1	1	1	1
PM_{10}		686	678	623	614
$PM_{2.5}$		100	99	93	92
KMC Emissions of Criteria Pollutants (pounds per day)					
NO_X		28397	28103	26261	25962
CO		84884	84904	85034	85055
SO_2		24	23	20	19
PM_{10}		7737	7494	5972	5726
$PM_{2.5}$		1143	1111	906	873
Maximum Impact at Off-site Receptors ($\mu g/m^3$) and Air Quality Standards (shaded)					
1-hour NO_2	188	145.3	143.2	130.0	127.8
Annual NO_2	10 0	14.2	13.9	12.1	11.8
1-hour CO	40,000	2020.7	2020.5	2019.6	2019.4
8-hour CO	10,000	4994.5	4961.7	4755.3	4721.8
1-hour SO_2	196	23.4	23.3	23.1	23.0
3-hour SO_2	1,300	20.6	20.6	20.0	20.0
24-hour PM_{10}	150	101.4	98.8	82.7	80.0
24-hour $PM_{2.5}$	35	18.8	19.0	19.9	20.1
Annual $PM_{2.5}$	12	5.9	5.9	6.0	6.0
Maximum Impact at Residence Receptors ($\mu g/m^3$) and Air Quality Standards (shaded)					
1-hour NO_2	188	124.5	122.9	113.3	111.7
Annual NO_2	100	13.2	12.8	10.7	10.3
1-hour CO	40,000	1978.6	1980.3	1991.1	1992.8
8-hour CO	10,000	2808.4	2854.2	3142.0	3188.6

Table 3.1-30 Emissions and Impacts of the Proposed KMC Operations Associated with the Renewable PFR Alternative

Parameter		Emissions / Impacts			
		3-Unit Operation		2-Unit Operation	
		100-MW Replacement	250-MW Replacement	100-MW Replacement	250-MW Replacement
1-hour SO_2	196	23.0	23.0	22.9	22.9
3-hour SO_2	1,300	19.6	19.6	19.7	19.7
24-hour PM_{10}	150	67.9	67.1	61.8	61.0
24-hour $PM_{2.5}$	35	16.9	16.9	16.3	16.3
Annual $PM_{2.5}$	12	5.7	5.7	5.5	5.5

Shaded numbers represent the NAAQS.

3.1.4.5.3 Transmission System and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance. Emissions and impacts would be the same as the Proposed Action.

3.1.4.5.4 Project Impact Summary – All Project Components

Although the emissions from NGS operations would lead to slight impacts near the proposed KMC operations, the maximum impacts for each operation would not be affected by those emissions. Therefore, the combined maximum impacts from all project components for the Renewable PFR Alternative would be based on the maximum impacts individually at NGS and the proposed KMC, and would be considered moderate levels of impact, similar to the Natural Gas PFR.

3.1.4.5.5 Cumulative Impacts

Cumulative impacts resulting from the Renewable PFR Alternative would be reflected in the impacts for NGS and the proposed KMC as provided above. The dispersion modeling analysis included background air quality concentrations for analyzing compliance with the NAAQS, and the combination of the modeled source impacts added to the background would represent the cumulative impacts for all sources. Impacts from power generated by the replacement facility would be negligible and well below the impact level established for major source air permitting; therefore, it was not included in the cumulative analysis.

Maximum cumulative impacts on ozone levels in the study area would occur at a location in southern Coconino County, near Flagstaff, Arizona. That design-value impact is approximately 76 ppb for both the 3-Unit Operation and 2-Unit Operation, with a reduction calculated to be 0.1 ppb following the installation of SCR at NGS. Given that the maximum impact would not change for the 3-Unit Operation and 2-Unit Operation, there would be no detectable impact on cumulative maximum ozone levels based on the Renewable PFR Alternative.

Similar to the Natural Gas PFR Alternative, the Renewable PFR Alternative would not have an effect on the maximum acid deposition levels.

3.1.4.6 Tribal Partial Federal Replacement Alternative

3.1.4.6.1 Navajo Generating Station

Under the Tribal PFR Alternative, between 100 MW and 250 MW of power generation from the NGS would be replaced by power supplied by a new photovoltaic generation facility on tribal land, displacing an equivalent amount of power from the federal share of NGS generation. The Tribal PFR facility would be analyzed in a separate National Environmental Policy Act process once a facility location is identified. Similar to the Renewable PFR Alternative, the Tribal PFR Alternative assumes that this installation would require firming power generation.

A transmission line may need to be constructed to support this alternative. Construction emissions would briefly affect air quality, but would be limited in area and duration. Air quality impacts from the transmission line operation would be negligible compared to the NAAQS; similar to the emissions and impacts associated with the Proposed Action.

The impacts provided in **Table 3.1-31** include only the impacts from NGS added to the background concentrations for the criteria air pollutants. Except for SO_2, the maximum impacts at NGS would be generated by surface level operations (e.g., mobile heavy equipment, coal and ash handling systems). As a result, there would be no reduction in impacts for these pollutants when compared to the range of impacts associated with the Proposed Action. The maximum impacts from NGS on ozone levels, acid deposition in Class I areas, and plume visibility at the maximum impacted vista are shown for NGS impacts only.

Table 3.1-31 Emissions and Impacts from NGS Associated with the Tribal PFR Alternative

Parameter	Emissions / Impacts			
	3-Unit Operation		2-Unit Operation	
	100-MW Replacement	250-MW Replacement	100-MW Replacement	250-MW Replacement
NGS Main Stack plus Natural Gas Firm Power Emissions of Criteria Pollutants and Selected HAP Metals (tons/year)				
Pre-SCR NO_X	20,019	19,436	13,216	12,633
Post-SCR NO_X	6,674	6,482	4,406	4,214
CO	14,303	13,892	9,444	9,033
SO_2	9,533	9,263	6,293	6,013
PM_{10}	2,009	1,971	1,340	1,281
$PM_{2.5}$	1,443	1,416	963	920
VOC	237	232	158	151
Arsenic	0.130	0.128	0.087	0.084
Mercury	0.114	0.111	0.076	0.072
Selenium	2.174	2.153	1.447	1.383
NH_3 Pre-SCR	0	0	0	0
NH_3 Post-SCR	43	42	28	27
H_2SO_4 Pre-SCR	46	45	30	29
H_2SO_4 Post-SCR	378	367	211	204

Table 3.1-31 Emissions and Impacts from NGS Associated with the Tribal PFR Alternative

Parameter		Emissions / Impacts			
		3-Unit Operation		2-Unit Operation	
		100-MW Replacement	250-MW Replacement	100-MW Replacement	250-MW Replacement
NGS Support Facility Emissions (tons/year)					
NO_X		58	56	49	46
CO		23	22	23	22
SO_2		1	1	1	1
PM_{10}		100	97	90	86
$PM_{2.5}$		15	15	14	13
VOC		6	6	5	5
Maximum Short-term Impacts ($\mu g/m^3$) and Air Quality Standards (shaded)					
1-hr NO_2	188	186.3	186.3	186.3	186.3
1-hr CO	40,000	4402.8	4402.8	4402.8	4402.8
1-hr SO_2	196	161.0	157.0	115.3	111.3
3-hr SO_2	1,300	104.4	102.1	77.1	74.8
24-hr PM_{10}	150	138.7	138.6	137.6	137.5
24-hr $PM_{2.5}$	35	32.7	32.7	32.6	32.6
8-hour Ozone (ppb)	70	2.3	2.3	2.1	2.1
Maximum Annual Average Impacts ($\mu g/m^3$) and Air Quality Standards (shaded)					
Pre-SCR NO_2	100	20.3	20.1	18.0	17.8
Post-SCR NO_2	100	18.2	18.1	16.7	16.6
$PM_{2.5}$	12	7.6	7.6	7.4	7.4
Maximum Acid Deposition (kg/hectare-year)					
Sulfur Deposition		0.036	0.035	0.024	0.023
Nitrate Deposition		0.059	0.057	0.040	0.038

Shaded numbers represent the NAAQS.

Annual power production from NGS would be reduced on an average basis, resulting in a reduction in power generation at NGS in a range of 2 to 5 percent for the 3-Unit Operation and 3 to 8 percent for the 2-Unit Operation (**Table 3.0-4**). This reduction could be applied to the annual emissions of pollutants from the main stacks; however, maximum daily emissions under this alternative could be the same as the Proposed Action for the 3-Unit Operation and 2-Unit Operation because there would be no associated restriction on a daily basis. The maximum short-term (daily and hourly) impacts for all pollutants (except SO_2) near the NGS ambient air quality boundary would be roughly the same because the emissions are dominated by surface level operations and would be just below the ambient standards. For SO_2 impacts, the daily and 1-hour maximum impacts could remain the same as the individual 3-Unit Operation and 2-Unit Operation because hourly operations would not be restricted by the Tribal PFR Alternative. Annual maximum impacts for the Tribal PFR Alternative for NO_2 prior to installation of SCR would be reduced by a range of less than 1 to 2 percent. (See **Tables 3.1-12** and **3.1-13** for the Proposed Action values.) Annual impacts on $PM_{2.5}$ levels would be roughly identical for the 3-Unit

Operation and 2-Unit Operation and would be just below the ambient standards. Impacts from NGS on air quality for this alternative would be considered moderate because of high impacts locally near the facility.

3.1.4.6.2 Proposed Kayenta Mine Complex

Under the Tribal PFR Alternative, mining operations at the proposed KMC would be reduced relative to the power generation reduction at NGS (**Table 3.0-6**). The environmental consequences of the Tribal PFR Alternative at the proposed KMC would be related to annual and daily coal production. Although the PFR alternatives were not specifically analyzed for air emissions or modeled for impacts to air quality, an estimate of those emissions and impacts was calculated based on the change in total coal production for each alternative. The method for estimating the emissions and impacts for the Tribal PFR Alternative was identical to that used for the Natural Gas PFR Alternative. **Table 3.1-32** provides a summary of annual and daily emissions and impacts associated with the Tribal PFR Alternative. Maximum impacts are provided separately for receptors off the proposed KMC lease area and for residence receptors on the proposed KMC lease area. All data are based on the maximum impact at any of the group receptors. Impacts would be well below the NAAQS and considered minor.

Table 3.1-32 Emissions and Impacts of the Proposed KMC Operations Associated with the Tribal PFR Alternative

Parameter		Emissions / Impacts			
		3-Unit Operation		2-Unit Operation	
		100-MW Replacement	250-MW Replacement	100-MW Replacement	250-MW Replacement
Proposed KMC Emissions of Criteria Pollutants (ton/year)					
NO_X		607	590	411	393
CO		524	508	342	325
SO_2		1	1	1	1
PM_{10}		688	683	625	619
$PM_{2.5}$		101	100	94	93
Proposed KMC Emissions of Criteria Pollutants (pounds per day)					
NO_X		28,465	28,274	26,330	26,136
CO		84,879	84,892	85,029	85,043
SO_2		24	23	20	19
PM_{10}		7,793	7,635	6,030	5,869
$PM_{2.5}$		1,151	1,130	914	892
Maximum Impact at Off-site Receptors (μg/m^3) and Air Quality Standards (shaded)					
1-hour NO_2	188	145.8	144.4	130.5	129.1
Annual NO_2	100	14.3	14.1	12.2	12.0
1-hour CO	40,000	2,020.7	2,020.6	2,019.6	2,019.5
8-hour CO	10,000	5,002.2	4,980.8	4,763.1	4,741.3
1-hour SO_2	196	23.4	23.4	23.1	23.1
3-hour SO_2	1,300	20.7	20.6	20.1	20.0
24-hour PM_{10}	150	102.0	100.3	83.3	81.6
24-hour $PM_{2.5}$	35	18.8	18.9	19.9	20.0
Annual $PM_{2.5}$	12	5.9	5.9	6.0	6.0

Table 3.1-32 Emissions and Impacts of the Proposed KMC Operations Associated with the Tribal PFR Alternative

Parameter		Emissions / Impacts			
		3-Unit Operation		2-Unit Operation	
		100-MW Replacement	250-MW Replacement	100-MW Replacement	250-MW Replacement
Maximum Impact at Residence Receptors ($\mu g/m^3$) and Air Quality Standards (shaded)					
1-hour NO_2	188	124.8	123.8	113.6	112.6
Annual NO_2	100	13.3	13.0	10.7	10.5
1-hour CO	40,000	1,978.2	1,979.4	1,990.7	1,991.8
8-hour CO	10,000	2,797.8	2,827.6	3,131.1	3,161.5
1-hour SO_2	196	23.0	23.0	22.9	22.9
3-hour SO_2	1,300	19.6	19.6	19.7	19.7
24-hour PM_{10}	150	68.1	67.6	62.0	61.5
24-hour $PM_{2.5}$	35	17.0	16.9	16.4	16.3
Annual $PM_{2.5}$	12	5.7	5.7	5.5	5.5

Shaded numbers represent the NAAQS.

3.1.4.6.3 Transmission System and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

Emissions and impacts would be the same as the Proposed Action unless transmission lines or communication sites needed to be constructed to service the replacement facilities. Temporary air quality emissions from construction operations would occur, but likely would be negligible compared to the NAAQS.

3.1.4.6.4 Project Impact Summary – All Project Components

Although the emissions from NGS operations would lead to slight impacts near the proposed KMC operations, the maximum impacts for each operation would not be affected by those emissions. Therefore, the combined maximum impacts from all project components for the Tribal PFR Alternative would be based on the maximum impacts individually at NGS and the proposed KMC.

3.1.4.6.5 Cumulative Impacts

Cumulative impacts resulting from the Tribal PFR Alternative would be reflected in the impacts for NGS and the proposed KMC as provided above. The dispersion modeling analysis included background air quality concentrations for analyzing compliance with the NAAQS, and the combination of the modeled source impacts added to the background would represent the cumulative impacts for all sources. Construction of the Tribal PFR Alternative would generate temporary air quality emissions, as would construction of any transmission line or other support systems to service the replacement facility. Those emissions would be temporary, and if controlled by an array of practices, likely would not exceed the NAAQS. Impacts from operation of the firming facility would be negligible and well below the impact level established for major source air permitting.

Maximum cumulative impacts on ozone levels in the study area would occur at a location in southern Coconino County, near Flagstaff, Arizona. That design-value impact is approximately 76 ppb for both the

3-Unit Operation and 2-Unit Operation, with a reduction calculated to be 0.1 ppb following the installation of SCR at NGS. Given that the maximum impact would not change for the 3-Unit Operation and 2-Unit Operation, there would be no detectable impact on cumulative maximum ozone levels based on the Tribal PFR Alternative.

Similar to the Natural Gas PFR Alternative, the Tribal PFR Alternative would not affect the maximum cumulative acid deposition levels.

3.1.4.7 No Action

3.1.4.7.1 Navajo Generating Station

With the No Action Alternative, power production at NGS would cease and all associated emissions and impacts from future operations would not occur. However, immediately following cessation of operations, there may be site closure and remediation activities that would generate emissions and lead to nearby impacts.

The ambient air quality conditions associated with the No Action Alternative at NGS would be represented by the assumed background concentrations related to dispersion modeling, except for those pollutants whose background concentrations were determined from the Glen Canyon monitor. The air quality for those pollutants could be slightly improved compared to existing conditions. The background data resources are discussed in Section 3.1.3 and reproduced in **Table 3.1-33** for the air quality around NGS. Short-term background conditions were based on the regulatory approach that applies to the standard (e.g., the 3-year average of the 99th percentile daily maximum 1-hour SO_2 level). The 1-hour NO_2 background was calculated for each seasonal hour, and the three-year average of the 2nd or 3rd highest ozone levels was used to characterize background 1-hour NO_2 levels. Ozone background levels were based on data collected at the Grand Canyon National Park and would be representative of the undeveloped area around the NGS site. Detailed discussion of the background concentrations is provided in Ramboll Environ (2016b [Section 4 and Table 4-1]). All data show compliance with the ambient air quality standards. Under the No Action Alternative, emissions of HAPs from NGS operations would cease. Impacts of soil and water-based chemicals of concern would continue based on the levels of those chemicals that exist within the soil; however, following any remedial activity no additional accumulation of those chemicals would occur.

Table 3.1-33 Background Ambient Air Quality Levels at NGS Representative of the No Action Alternative

Parameter	Background Concentration ($\mu g/m^3$)	Monitor Location	Years
1-hour NO_2	51 (max seasonal)	Hurricane, St. George, UT	2012-2014
1-hour CO	2,634	JGL Supersite, Phoenix area	2008-2012
1-hour SO_2	22.5	Glen Canyon Monitor	2008-2012
24-hour PM_{10}	44.5	Glen Canyon Monitor	2008-2012
24-hour $PM_{2.5}$	20.8	Glen Canyon Monitor	2008-2012
8-hour Ozone (ppb)	68.1	Grand Canyon	2008-2012
Annual NO_2	6.0	Hurricane, UT	2012-2014
Annual $PM_{2.5}$	5.9	Glen Canyon Monitor	2008-2012

3.1.4.7.2 Proposed Kayenta Mine Complex

Under the No Action Alternative, the proposed KMC operations would cease. Temporary emissions would be associated with reclamation activities until the site has received final bond release. Air quality levels measured as background concentrations at the proposed KMC capture both the occasional impacts from the proposed KMC operations when the wind direction transports the mining emissions to the monitor, and the measured concentrations would represent the No Action Alternative conditions when the wind is blowing from other directions. As a result the background concentrations used for modeling would provide a conservative estimate of air quality conditions following closure of the mine (**Table 3.1-19**).

3.1.4.7.3 Transmission Systems and Communication Sites

The NGS transmission system is an established part of the western U.S. transmission grid and supports reliability and delivery of power throughout the region, well beyond the power generated by the NGS. Therefore, under all alternatives it is likely that that one, several, or all of the land owners/managers of the transmission line rights-of-way and communication site leases would renew some portion of the facilities to keep the power grid performing as expected.

In the event it is determined that some or all of the transmission systems and communication site ROWs are not renewed, a lengthy study and permitting process would need to occur before any decommissioning is initiated due to the essential and integral nature of these facilities with the western electric grid. As noted in Section 2.3.3, up to 4,826 acres within and alongside the transmission system corridors could be temporarily disturbed if the entirety of the transmission systems and communication sites were decommissioned and removed resulting in minor, localized emissions impacts.

3.1.4.7.4 Project Impact Summary – All Project Components

As demonstrated above, the existing air quality conditions are in compliance with the NAAQS in the study area. Background concentration data are identified above and would provide the best estimate of air quality conditions for the No Action Alternative. The modeled maximum impacts of emissions, especially near the NGS and proposed KMC operations would not occur. The regional impacts on ozone, acid deposition, and haze levels also would not occur; however, the regional maxima for ozone and acid deposition would not be affected because they are located at distances far from NGS and the proposed KMC, where those impacts are generally less than 1 percent of the observed or modeled impacts.

Short-term moderate increases in fugitive dust and equipment emissions would occur during decommissioning operations at both NGS (2018 to 2019) and the Kayenta Mine (over a minimum 10-year period starting in 2 019).

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Section 3.2

Climate and Climate Change

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Acronyms and Abbreviations

ºC	degrees Celsius
ºF	degrees Fahrenheit
1969 Lease	Navajo Project Indenture of Lease
BART	Best Available Retrofit Technology
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BM&LP Railroad	Black Mesa & Lake Powell Railroad
BO	Biological Opinion
CAP	Central Arizona Project
CAWCD	Central Arizona Water Conservation District
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
Co-tenants	Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
Development Fund	Lower Colorado River Basin Development Fund
EIS	Environmental Impact Statement
ERA	Ecological Risk Assessment
ESA	Endangered Species Act of 1973
GHG	Greenhouse Gas
HHRA	Human Health Risk Assessment
IPCC	Intergovernmental Panel on Climate Change
IWG	Interagency Working Group
km	kilometer
KMC	Proposed Kayenta Mine Complex
kV	kilovolt
kW	kilowatt
MW	megawatt
N-Aquifer	Navajo Aquifer
NEPA	National Environmental Policy Act of 1969, as amended
NGS	Navajo Generating Station
NGS Participants	U.S. (Reclamation), Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
NHPA	National Historic Preservation Act
NNEPA	Navajo Nation Environmental Protection Agency
NO_2	nitrogen dioxide
NO_X	nitrogen oxide
OSMRE	Office of Surface Mining Reclamation and Enforcement

PFR	Partial Federal Replacement
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 microns or less
PWCC	Peabody Western Coal Company
Reclamation	U.S. Bureau of Reclamation
ROW	Right-of-way
SCC	Social Cost of Carbon
SO_2	Sulfur dioxide
SRP	Salt River Project Agricultural Improvement and Power District
STS	Southern Transportation System
tpy	tons per year
USD	U.S. dollars
U.S.	United States
USEPA	U.S. Environmental Protection Agency
WTS	Western Transportation System

Contents

3.2 Climate and Climate Change ... 3.2-1
3.2.1 Regulatory Framework ... 3.2-1
3.2.2 Study Areas ... 3.2-2
3.2.2.1 Proposed Action and Action Alternatives ... 3.2-2
3.2.2.2 Localized Effects of Climate Change on Socioeconomic Conditions ... 3.2-2
3.2.3 Affected Environment ... 3.2-3
3.2.3.1 Navajo Generating Station ... 3.2-3
3.2.4 Environmental Consequences ... 3.2-13
3.2.4.1 Issues ... 3.2-13
3.2.4.2 Assumptions and Impact Methodology ... 3.2-22
3.2.4.3 Proposed Action ... 3.2-26
3.2.4.4 Natural Gas Partial Federal Replacement Alternative ... 3.2-32
3.2.4.5 Renewable Partial Federal Replacement Alternative ... 3.2-36
3.2.4.6 Tribal Partial Federal Replacement Alternative ... 3.2-40
3.2.4.7 No Action ... 3.2-43
3.2.5 References ... 3.2-46

List of Appendices

Appendix 3.2-A - Stream Flow Data by Year

Appendix 3.2-B - Precipitation and Temperature Data

Appendix 3.2-C - Greenhouse Gas Emissions Data

Appendix 3.2-D - GHG Emissions from PFR Alternatives

Appendix 3.2-E - Emissions from Bowie Power Plant

List of Tables

Table 3.2-1 Estimated Social Cost of Carbon ... 3.2-25
Table 3.2-2 GHG Emissions from NGS for the Proposed Action ... 3.2-26
Table 3.2-3 GHG Emissions from Proposed KMC for the Proposed Action ... 3.2-27
Table 3.2-4 Total Project GHG Emissions for Proposed Action and Contribution to Projected Global Emissions in 2040 ... 3.2-28
Table 3.2-5 Total Proposed Action Contribution to Global GHG Emissions ... 3.2-29
Table 3.2-6 Social Cost of Carbon for the Proposed Action ... 3.2-31
Table 3.2-7 Social Cost of Carbon for the Federal Share of NGS ... 3.2-31
Table 3.2-8 GHG Emissions Associated with the Natural Gas PFR Alternative ... 3.2-32
Table 3.2-9 GHG Emissions from Proposed KMC for the Natural Gas PFR Alternative ... 3.2-33
Table 3.2-10 Total Project Contribution to Global GHG for the Natural Gas PFR Alternative ... 3.2-34
Table 3.2-11 Total Natural Gas PFR Alternative Contribution to Global GHG ... 3.2-34
Table 3.2-12 Social Cost of Carbon for the Natural Gas PFR Alternatives ... 3.2-35
Table 3.2-13 Social Cost of Carbon for the Federal Share of NGS with Natural Gas PFR ... 3.2-35
Table 3.2-14 GHG Emissions Associated with the Renewable PFR Alternative ... 3.2-36
Table 3.2-15 GHG Emissions from Proposed KMC for the Renewable PFR Alternative ... 3.2-37
Table 3.2-16 Total Project Contribution to Global GHG for Renewable PFR Alternative ... 3.2-38
Table 3.2-17 Total Renewable PFR Alternative Contribution to Global GHG Emissions ... 3.2-38
Table 3.2-18 Social Cost of Carbon for the Renewable PFR Alternative ... 3.2-39
Table 3.2-19 Social Cost of Carbon for the Federal Share of NGS with Renewable PFR ... 3.2-39
Table 3.2-20 GHG Emissions Associated with the Tribal PFR Alternative ... 3.2-40
Table 3.2-21 GHG Emissions from Proposed KMC for the Tribal PFR Alternative ... 3.2-41
Table 3.2-22 Total Project Contribution to Global GHG for Tribal PFR Alternative ... 3.2-41
Table 3.2-23 Total Tribal PFR Alternative Contribution to Global GHG Emissions ... 3.2-42
Table 3.2-24 Social Cost of Carbon for the Tribal PFR Alternative ... 3.2-43
Table 3.2-25 Social Cost of Carbon for the Federal Share of NGS with Tribal PFR ... 3.2-43
Table 3.2-26 Estimated Social Cost of Carbon for No Action Alternative ... 3.2-45
Table 3.2-27 Estimated Social Cost of Carbon for No Action Alternative Compared to Proposed Action Operations ... 3.2-45

List of Figures

Figure 3.2-1 National Precipitation Trends ... 3.2-4
Figure 3.2-2 Total Annual Flow in Streams that Feed Lake Powell ... 3.2-5
Figure 3.2-3 Average Monthly Total Precipitation ... 3.2-6
Figure 3.2-4 Average Monthly Total Snowfall ... 3.2-7
Figure 3.2-5 Distribution of Annual Precipitation Totals for Betatakin (73-year record) and Canyon de Chelly (91 year record) ... 3.2-7
Figure 3.2-6 Average Annual Temperature ... 3.2-9
Figure 3.2-7 Monthly Total Precipitation Statistics at Canyon de Chelly from 1909 to 2014 ... 3.2-10
Figure 3.2-8 Observed Annual and Monsoon Season Total Precipitation at Canyon de Chelly ... 3.2-11
Figure 3.2-9 Total Annual San Juan River Flow at Bluff, Utah ... 3.2-12
Figure 3.2-10 Observed and Predicted Changes in Annual Average Temperature and Annual Precipitation ... 3.2-23

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3.2 Climate and Climate Change

3.2.1 Regulatory Framework

A changing climate poses challenges to the global social and economic structure as well as potential impacts on the natural environment. The accumulation of constituent atmospheric gases that inhibit the radiative cooling of the earth's surface are generally acknowledged to contribute to a changing climate both world-wide and on local or regional scales. These constituents are referred to as greenhouse gases (GHGs) in this document and in most references cited here.

A wide array of analyses and climate projections are underway to guide society and government agencies in understanding and addressing climate change, both to reduce the GHGs that are leading to a steady warming of the planet and to implement adaptations to the effects of climate change. The United States (U.S.) Council on Environmental Quality (CEQ) has identified climate change as an important consideration in the analysis of major federal actions that may affect climate and has issued draft and final guidance for addressing climate change in federal actions (CEQ 2016, 2014a).

This analysis relies extensively on the Intergovernmental Panel on Climate Change (IPCC), Fifth Assessment (IPCC 2014a,b,c, 2013), a four-volume set that addresses climate change, as a resource of existing environment and for predicting climate change during the period of the Proposed Action as well as the regional analyses provided by Garfin et al. (2013; IPCC 2014a).

The U.S. Bureau of Reclamation (Reclamation) has established its own Climate Adaptation Strategy (Reclamation 2014), which also is incorporated into this analysis. Reclamation's strategy recognizes that the weather and stream flow patterns that framed the development of the Western U.S. are changing, and that these changes affect the ability to deliver needed quantities of water and power to agricultural, Tribal, municipal, and industrial water users, as well as maintaining water for environmental flows and to support ecosystems. The goals of Reclamation's strategy are fourfold:

- Increase water management flexibility;
- Enhance climate adaptation planning;
- Improve infrastructure resiliency; and
- Expand information sharing.

The components of flexibility, planning, and resiliency are referenced in this section in terms of evaluating the Proposed Action and the relevant alternatives under consideration. This strategy also is aligned with the U.S. Department of Interior's Climate Adaptation Policy (U.S. Department of the Interior 2016), which calls on the Department's Bureaus to incorporate climate adaptation into agency decision making.

Executive Order 12866 on Regulatory Planning and Review, requires federal agencies, to the extent permitted by law, "…assess both the costs and the benefits of (an) intended regulation." Executive Order 13563 on Improving Regulation and Regulatory Review "reaffirms the principles, structures and definitions…established in Executive Order 12866…." Although this Environmental Impact Statement (EIS) does not address a proposed regulatory action, the federal Interagency Working Group (IWG) on Social Cost of Carbon (SCC) has asserted that SCC estimates can be useful in estimating the social benefits of reducing carbon dioxide emissions (IWG on SCC 2010). More recently, the Office of Management and Budget (2014) reiterated its conclusion that "…the SCC estimates provide valuable and critical insights for decisions makers and the public as they consider the costs and benefits of alternative policy choices….."

The CEQ's National Environmental Policy Act (NEPA) Revised Draft Greenhouse Gas Guidance notes that "…although developed specifically for regulatory impact analyses, federal SCC, which multiple federal agencies have developed and used to assess the costs and benefits of alternatives in rulemakings, offers a harmonized, interagency metric that can provide decision makers and the public with some context for meaningful NEPA review. When using the federal SCC, the agency should disclose the fact that these estimates vary over time, are associated with different discount rates and risks, and are intended to be updated as scientific and economic understanding improves" (CEQ 2014a).

The final CEQ guidance (CEQ 2016) states that "when an agency determines that a monetized assessment of the impacts of greenhouse gas emissions or a monetary cost-benefit analysis is appropriate and relevant to the choice among different alternatives being considered, such analysis may be incorporated by reference or appended to the NEPA document as an aid in evaluating the environmental consequences." For this EIS, the greenhouse gas emission rate is an important differentiating factor among alternatives. When an EIS addresses economic benefits of an action, it is helpful to also disclose potential costs. The estimated Social Cost of Carbon presented later in this section is a proxy measure for such costs as related to climate change, providing a means for comparing the alternatives.

The final CEQ guidance states that the EIS should provide the decision-maker and the public with a recognizable frame of reference for comparing alternatives and mitigation measures. Section 1.8 provides an overview of the USEPA Clean Power Plan published in October 2015. The Clean Power Plan would establish carbon emission performance limits for various state and tribal jurisdictions. The effect of the Clean Power Plan on future operations at NGS is currently unknown, pending resolution of legal challenges to the rule, as well as a final determination regarding implementation of the Clean Power Plan on Navajo Nation lands. If or when the Clean Power Plan is implemented, it would provide a framework for evaluating future reductions in greenhouse gases at NGS that have been estimated under the various alternatives in this EIS.

Emissions of carbon dioxide (CO_2) and other GHGs (methane and nitrous oxide) are recognized as change agents contributing to global climate change. A wide range of effects to the human and natural environments are anticipated in conjunction with rising temperatures. Many of those effects involve externalities, that is, effects to resources and populations that are not reflected in market transactions and for which economic values are not established or recognized. Rising sea levels and potential damages to physical infrastructure, economies, and social disruption in coastal areas associated with such rises are examples of these externalities. Increased recognition and consideration of externalities is an important element of the ongoing analysis of climate change policy in the past several decades (CEQ 2014b; IPCC 2014c; National Science and Technology Committee 2008).

3.2.2 Study Areas

3.2.2.1 Proposed Action and Action Alternatives

The study area for characterizing climate covers southern Utah and Northeastern Arizona. This area includes an assessment of current conditions as well as the current changes or trends in climate conditions being observed. As climate changes in the region the Proposed Action may affect or be affected by the changing climate. Conditions and trends in a regional study area that includes the Proposed Action would form a pattern relevant to the evaluation of the projected change and its environmental consequences on resources being affected by climate change as well as how climate change could affect the design and operation of the Proposed Action. This study area includes the region that supplies water to Lake Powell because the Proposed Action and action alternatives would be affected by the availability of Colorado River water flow.

3.2.2.2 Localized Effects of Climate Change on Socioeconomic Conditions

All project components are located in the U.S. Southwest. The current state of the practice for climate change assessment does not extend to specific locations. Consequently, the long-term outlook for climate change conditions for the U.S. Southwest were used to provide a broad framework consideration of potential impacts from climate change on socioeconomic conditions in northeastern and central Arizona. The primary study area for localized effects of climate change on socioeconomic conditions includes the Navajo Nation, Hopi Reservation, and northern Coconino and Navajo counties, Arizona, with a focus on the Navajo chapters and portions of the Hopi Reservation surrounding the Navajo Generating Station (NGS) and proposed Kayenta Mine Complex (KMC) as well as the nearby off-reservation communities in the two counties, particularly Page. A secondary study area includes the transmission line corridors, communications sites and the portions of central and southern Arizona that encompass the service area for the Central Arizona Project (CAP).

The transmission system and communication sites include portions of three Indian Reservations and five counties in Arizona, Utah, and Nevada. A key concern would be the frequency and severity of extreme weather events and wildfires, which have the potential to disrupt service, damage the transmission lines and communication sites, and require additional maintenance or reconstruction.

3.2.3 Affected Environment

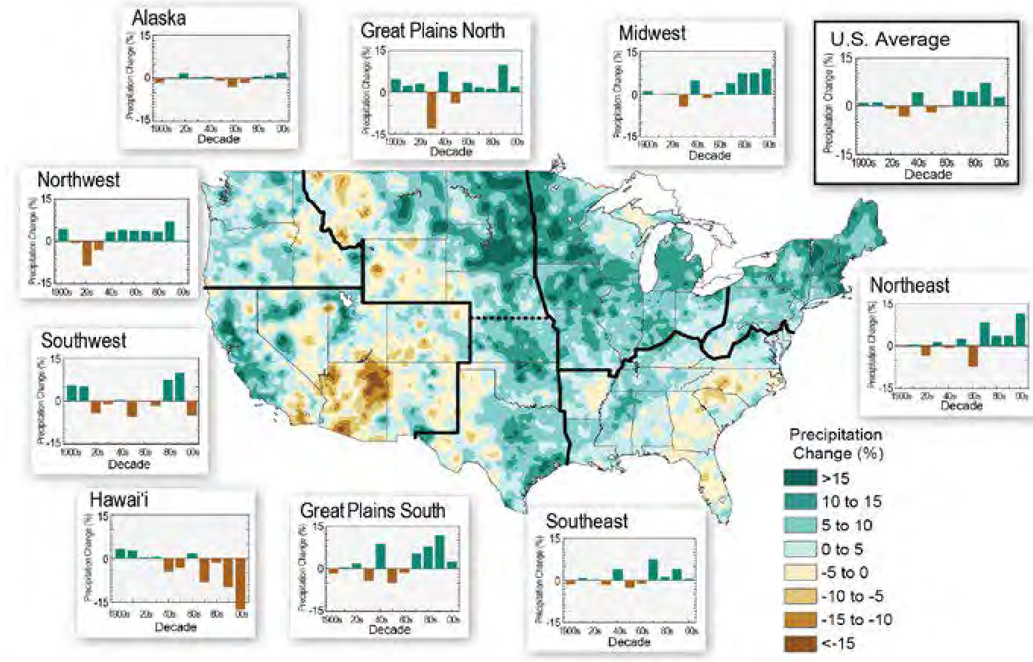
3.2.3.1 Navajo Generating Station

3.2.3.1.1 Global and Regional Temperatures and Precipitation

Globally, atmospheric surface temperatures have risen steadily for the past several decades (IPCC 2013). Regional temperature patterns over North America are affected by an array of large-scale atmospheric phenomena and cycles that may affect temperatures differently in various locations and during the separate seasons. These cycles lead to persistent weather patterns that vary substantially from year-to-year and include extended periods (i.e., including years) of temperatures that are above or below average. A general surface warming over North America has been documented since 1900, and particularly in the U.S. Southwest since 1981 (IPCC 2013). Figure 2.22 in IPCC (2013) indicates that the U.S. Southwest has shown some substantial warming over the 20th Century, estimated at approximately 2°F in Northern Arizona.

The Assessment of Climate Change in the Southwest U.S. (Hoerling et al*.* 2013) summarizes a broad increase in temperatures over the six-state U.S. Southwest. The average daily maximum temperature increased by 1.4°F from the 1901 to 2000 average to the 2001 to 2010 10-year average. It is notable that the average daily minimum temperature for the same comparison increased by 2.2°F, and this increase was strongest in the latter half of the period. Hoerling et al. (2013) also observed fewer cold waves and more heatwaves over the U.S. Southwest during 2001 to 2010 than during the previous century.

The overall regional precipitation trends are less clear than the regional depictions of temperature changes. Over the globe as a whole, when virtually all the land area is taken into consideration, the resulting time series shows little change in land-based precipitation since 1901 (IPCC 2013). While the total moisture levels in the atmosphere have increased, the relative humidity has decreased primarily due to the concurrent increase in temperature. The IPCC panel assessment indicates low confidence in determining a trend in precipitation that is associated with the changing climate. However, the National Climate Assessment (Walsh et al*.* 2014) shows a 10 percent to 15 percent reduction in local precipitation over northeastern Arizona when comparing the 1991 to 2012 annual average to the 1901 to 1960 annual average. **Figure 3.2-1** from Peterson et al. (2013) shows a pattern of reduced precipitation over northeastern Arizona. This reduction is unique in that it is the most dramatic reduction in total annual average precipitation across the continental U.S. as well as the U.S. Southwest.



Source: Peterson et al. 2013.

Note: The colors on the map show annual total precipitation changes for 1991 to 2012 compared to the 1901 to 1960 average, and show wetter conditions in most areas. The bars on the graphs show average precipitation differences by decade for 1901 to 2012 (relative to the 1901 to 1960 average) for each region. The far right bar in each graph is for 2001 to 2012.

Figure 3.2-1 National Precipitation Trends

3.2.3.1.1.1 Colorado River Runoff

Figure 3.2-2 provides a history of Colorado River flow at five streams that feed into Lake Powell (Reclamation 2005). The figure shows a long-term drop in river flows, with considerable interannual variability. A separate analysis concluded that the water flow at Lees Ferry is representative of the annual water flow into Lake Powell above the Glen Canyon Dam. See data and analyses in **Appendix 3.2-A**, Exhibit 1.

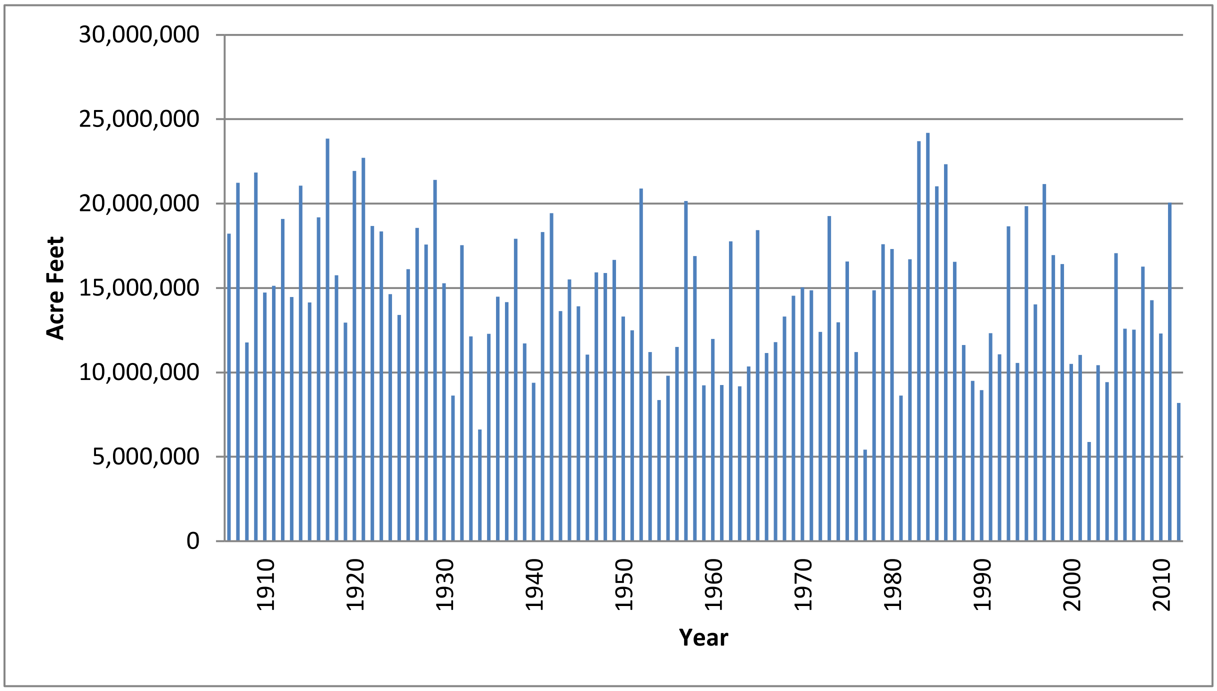


Figure 3.2-2 Total Annual Flow in Streams that Feed Lake Powell

Statistical analysis of the individual yearly runoff data depicts an average (linear slope) decrease of approximately 33,000 acre-feet per year over the period from 1906 to 2012, with the linearized runoff level at 16.67 million acre-feet in 1906 and 13.11 million acre-feet in 2012. While the linear estimate cannot be used to predict any one year's total runoff, the long-term trend in the data is a basis for characterizing the total decline in runoff during that period.

3.2.3.1.1.2 Growing Season

Cayan et al. (2013) depict the climatological freeze-free season throughout the U.S. Southwest. Over northeastern Arizona, the length of that season varies from about 150 to 200 days (Cayan et al. 2013). Hoerling et al. (2013) also point out that the growing season in the U.S. Southwest increased approximately 17 days from 2001 to 2010 compared to the average growing season length in the 20th Century.

3.2.3.1.2 Temperature and Precipitation at Regional Sites

The climate of the Proposed Action study area was assessed by examining climatological parameters collected and maintained by the Western Regional Climate Center (2014). Summaries have been provided for nearby sources with extensive records. Although some of the station monitoring programs have been discontinued, the available data have been provided as a reference and a general depiction of regional temperatures, precipitation, and snowfall.

The local climatological conditions were determined by examining the meteorological record at separate sites, including Pinon, Kayenta, and Page, Arizona. These sites span the region and include a representation of elevation within the region. The seasonal pattern is clearly dominant with the highest seasonal average temperatures in July and early August and the lowest seasonal temperatures in December and January. Average wintertime low temperatures are in the teens, but the data record shows a number of very low temperature extremes near negative 20 degrees Fahrenheit (-20°F) at the higher elevation sites.

Precipitation patterns also are represented by the record at each of these sites as well as at Betatakin and Canyon de Chelly. **Figure 3.2-3** depicts the average monthly total precipitation for the five stations for each month of the year. Detailed precipitation data for these sites are provided in **Appendix 3.2-B**, Exhibit 1. The pattern shows a consistent seasonal feature, including the maximum precipitation in July to October at all sites. This precipitation/weather pattern is referred to as the Southwest Monsoon, which brings critical rainfall to support crop production as well as support for the native vegetation and pastures. The monsoon feature is strongest at the sites with higher elevations. Winter precipitation can occur as rain or snow and results from the passage of mid-latitude storm systems from west to east during that season. Annual average precipitation ranges from 6.44 inches at Page, to 7.66 inches at Kayenta, 8.88 inches at Pinon, 9.14 inches at Canyon de Chelly, and to 11.94 inches at Betatakin.

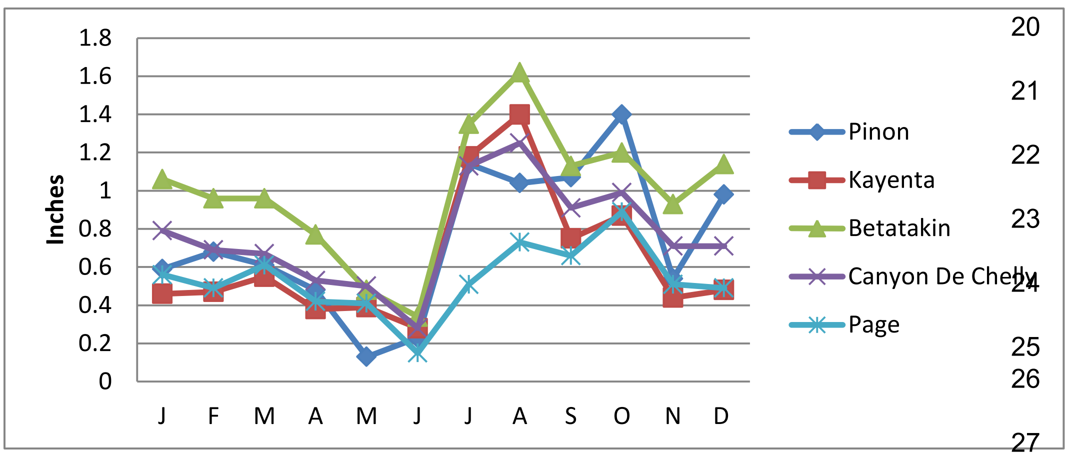


Figure 3.2-3 Average Monthly Total Precipitation

Snowfall also is a climatic feature for winter months, and generally is higher at higher elevations. The monthly average total snowfall for these same five sites is shown in **Figure 3.2-4**. Snow falls from November through April and is greatest at Betatakin and least at Page.

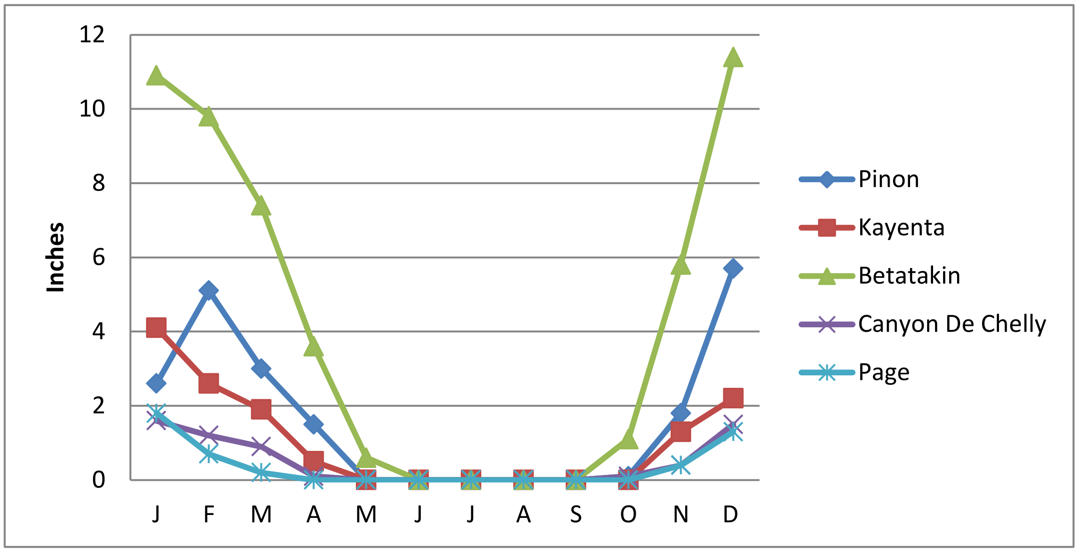


Figure 3.2-4 Average Monthly Total Snowfall

Figure 3.2-5 depicts the distribution of yearly total precipitation at two sites, including Betatakin and Canyon de Chelly. The data are categorized by ranges of total annual precipitation in inches) and represents the number of years in each precipitation category. There are a substantial number of wet and dry years at both sites, but most years are below average at Canyon de Chelly, while the annual pattern is more broadly distributed and generally has greater precipitation at Betatakin near the Black Mesa.

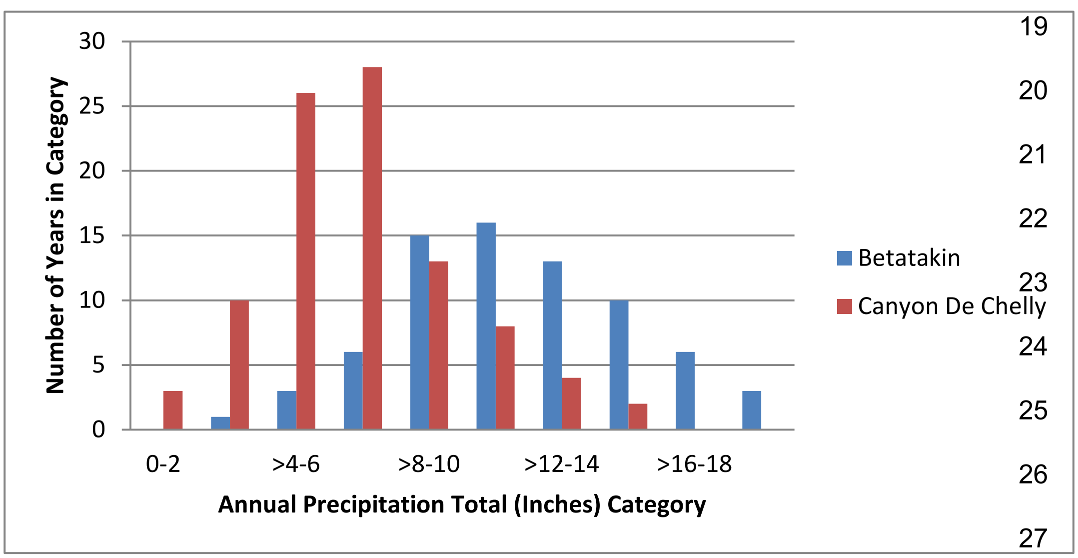


Figure 3.2-5 Distribution of Annual Precipitation Totals for Betatakin (73-year record) and Canyon de Chelly (91 year record)

Overall, climatic conditions in this region exhibit a great deal of variability, both daily and annually. Temperature and precipitation patterns also are greatly affected by elevation in this region.

3.2.3.1.3 Regional Climate Trends

The evaluation of climate change as part of this NEPA analysis includes characterization of climate change as part of the existing environment, and characterization of climate change that is reasonably foreseeable during the period of the Proposed Action. The reviews summarized below cover the physical basis of climate change and climate change related to ecosystem water resources, and the human environment, including agriculture and socioeconomics. For each of these components, the analysis provides: a description of global and regional climate as the existing environment; the effect of the Proposed Action; and the cumulative effect of the Proposed Action, including projected changes in climate for the duration of the Proposed Action.

The review of climate change addresses the unique character of the region. There are three distinct climates within the Navajo Nation and Hopi Reservation: the cold humid climate of the heights; the steppe climate of the mesas and the high plains; and the comparatively warm desert, including the lower portions of the Chaco and Chinle Valleys and all of the southern, western, and northwestern parts of the Navajo Nation. Eight percent of the area is classified as humid, 37 percent as steppe, and 55 percent as desert.

Each of these zones has a distinctive climate (Navajo Ways in Government 1963).

- The humid zone temperatures average from 43°F to 50°F with a low of 4°F and a high of 80°F. The annual rainfall is from 16 to 27 inches and the growing season averages 95 days.
- The steppe zone annual average temperature ranges from 45°F to 50°F with a low of 10°F and a high of 88°F. Annual rainfall is from 12 to 16 inches and the growing season averages 147 days.
- The desert-zone temperatures average 50°F to 60°F with a low of 11°F and a high of 110°F. Annual rainfall is between 7 and 11 inches and the growing season averages 173 days.

A spatial depiction of the average change in temperature in this region is provided by The Third National Climate Assessment (Walsh et al. 2014), which shows the increase in temperature for the 1991 to 2012 period compared to the 1901 to 1960 period was between 1.0°F and 1.5°F over the Navajo Nation and Hopi Tribal area, but greater than 1.5°F over most of Arizona and southern Utah.

As an example of the local patterns, reflected in three stations in the region (Western Regional Climate Center 2014) with a long-term record, **Figure 3.2-6** shows the past change in annual average temperatures at these locations. Detailed temperature data are provided in **Appendix 3.2-B** Exhibit 2. The data show a continual increase in average temperature, masked with considerable variability. Years with insufficient record are not included in this depiction. The average annual temperature at Canyon de Chelly increases by approximately 0.07°F per year, on a linear average, which is negligible compared to the year-to-year variability. Monthly data show a steady increase in average July monthly minimum temperatures. Data for January show that prior to 1940 there were occasional months with very low average minimum January temperatures below 0°F; however, none of the average January minimum temperatures have been below 10°F since 1980. This pattern implies that some occasional extremely cold months that occurred in the early half of the 20th Century no longer occur in the region, consistent with the consensus provided by Hoerling et al. (2013). The temperature data for Betatakin and Page show a less dramatic trend and cover a shorter period. These differences expose the variability of trends in temperature that exist over the region.

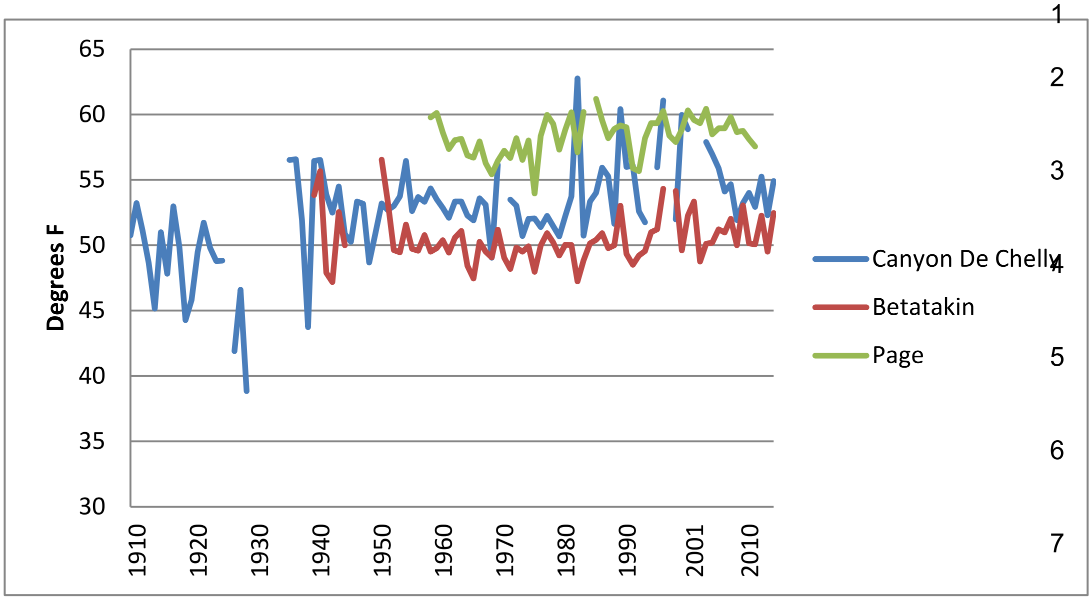


Figure 3.2-6 Average Annual Temperature

The long-term temperature changes at Canyon de Chelly indicate a relatively steady increase in average daily temperatures, but with a substantial variability in data from year-to-year.

3.2.3.1.3.1 North American Monsoon

The annual local/regional precipitation pattern is dominated by the North American Monsoon, with clearly evident mid-late summer peaks, as depicted in **Figure 3.2-7** for Canyon de Chelly. Detailed data for Canyon de Chelly precipitation are provided in **Appendix 3.2-B**, Exhibit 3. This monsoon climatic feature dominates the weather patterns in late summer, and brings a steady flow of moisture from the southwest over Arizona, the Black Mesa, and the Four Corners Region in general. The annual or seasonal pattern of precipitation in the region exhibits a monthly bimodal distribution, with wintertime rain and snow providing a slight peak, and the Rocky Mountain Monsoon, or North American Monsoon providing a dominant annual peak in mid- to late-summer (July-August). The wintertime precipitation develops as part of a global shift in the storm tracks or jet stream southward during the colder months. Precipitation associated with the passing storms can be highly variable both within individual storms but also from year-to-year.

The monthly precipitation exhibits a wide range of variability from year to year at locations in northeastern Arizona, including the Navajo Nation, for which the data from Canyon de Chelly is used to depict the range and standard deviation. As can be deduced from **Figure 3.2-7**, the mean seasonal peaks in precipitation are evident along with a wide range of inter-annual variability, with monthly standard deviations in total precipitation approximately equal to the mean values. The precipitation for each month has at least 1 year with no measured precipitation, while the maximum individual monthly totals can be 3 to 5 times the monthly mean.

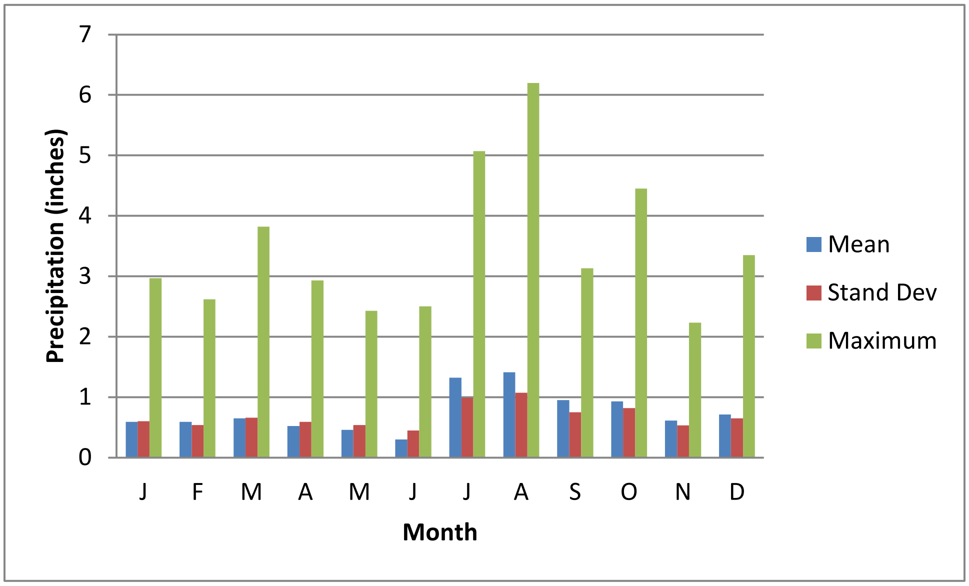


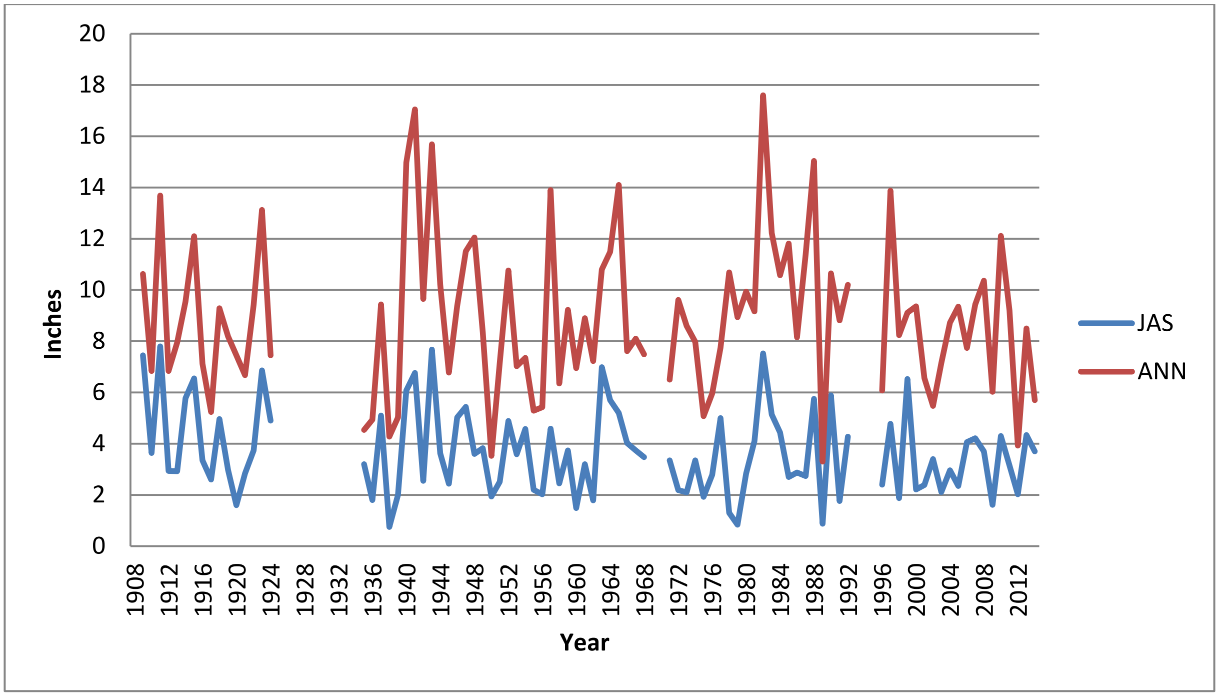
Figure 3.2-7 Monthly Total Precipitation Statistics at Canyon de Chelly from 1909 to 2014

In the North American Monsoon System, no distinct changes in precipitation patterns have been observed over the last half of the 20th Century (Anderson et al. 2010), but a positive trend in precipitation has been detected in northern Arizona and western New Mexico. There has been a systematic delay in monsoon onset, peak period, and termination (Grantz et al. 2007). Locally, precipitation patterns at Canyon de Chelly show a slight reduction in total precipitation both on an annual basis and for the regular monsoon season (July, August, and September), as shown in **Figure 3.2-8**. This figure also shows that the relatively high peaks that occurred regularly in the 20th Century have not been recorded since the mid-1990s.

3.2.3.1.3.2 Water Supply

Climate change can affect many activities that rely on a steady supply of surface water, and can have an effect on recharge of groundwater as well. Many studies have addressed these issues, particularly in arid and semi-arid regions such as the U.S. Southwest. This water supply analysis primarily relies on a summary that has been prepared for the National Climate Assessment (Udall 2013).

Water supply in this region is dependent on two separate factors: supply through direct precipitation and supply through runoff collected in the river basins, specifically the Colorado River, for delivery to regional users. While there are relationships in these two features, the nature of the changes in water supply related to climate change are distinctly different. Generally with the increased temperature, leading to increased evaporation, the water demands for any outdoor use, such as agriculture and surface watering, would increase. The higher temperatures also would lead to increased evapotranspiration from plants, and the longer growing season would increase water demand.



Note: ANN = observed annually; JAS = monsoon season July, August, and September.

Figure 3.2-8 Observed Annual and Monsoon Season Total Precipitation at Canyon de Chelly

Surface water quantity also is affected by climate change and is sensitive to changes in temperature and patterns of precipitation. The recent record of precipitation patterns and runoff patterns demonstrates that the existing water supply environment is changing in response to climate change. These current changes are highlighted in this section.

On the Navajo Nation, decreasing snowfall, increasing temperatures, and declining streamflow has been observed from 1996 to the current period (Redsteer et al. 2010). Anecdotal evidence shows that stream flows along with springs and other surface water features has changed substantially during the last century. Some historic ephemeral streams have experienced no flow during spring run-off and summer rains in recent years (Redsteer et al*.* 2013).

One of the key elements of water supply and water quality is the recharge of aquifers from annual rainfall. On the Black Mesa, the N-Aquifer is an important water resource that is recharged seasonally from precipitation in the highlands, principally during the winter and spring (Zhu and Kipfer 2010). The Shonto area in the northwestern corner of the mesa, accounts for approximately one-third of the total recharge in the basin and most of the water that flows into the center of the basin (Cooley et al. 1969).

While anecdotal evidence indicates that there have been reduced stream flows on the Navajo Nation lands, direct formal long-term records are not available. One reliable long-term record would be the annual river flows from the San Juan River measured at Bluff, Utah. Upstream of this site, the San Juan River drains a large portion of the Navajo Nation and would be representative of long-term changes in surface water flows, largely in response to local precipitation and spring runoff of mountain precipitation. **Figure 3.2-9** depicts the total annual San Juan River flow at Bluff, Utah. Detailed data are provided in **Appendix 3.2-B**, Exhibit 1.

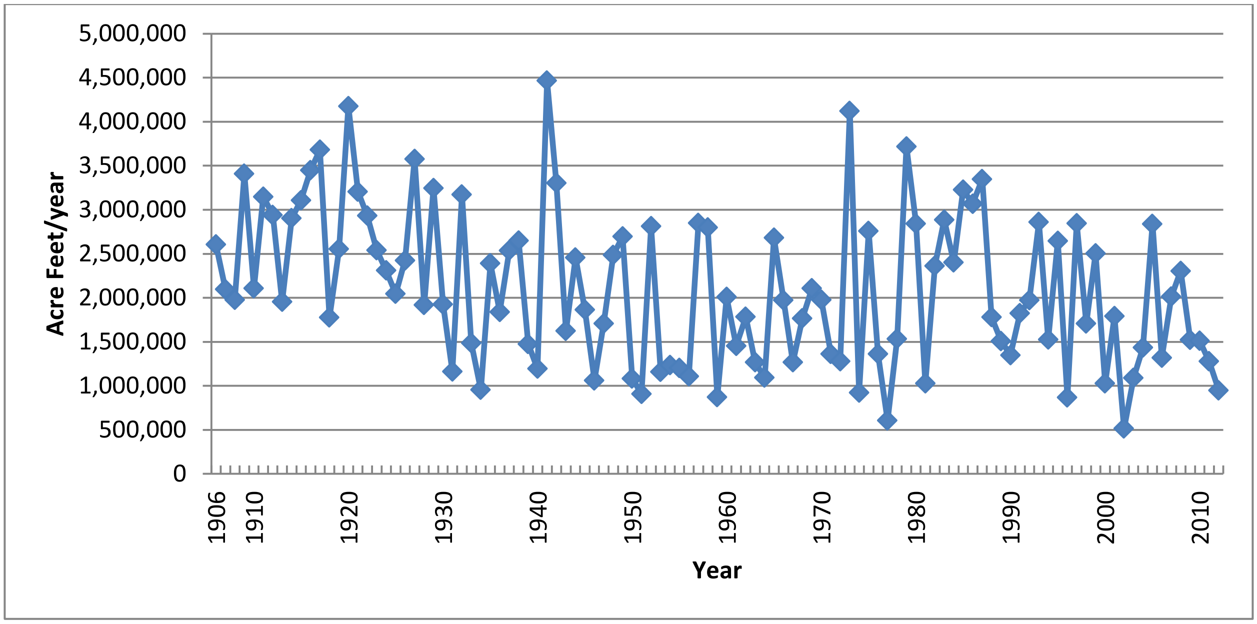


Figure 3.2-9 Total Annual San Juan River Flow at Bluff, Utah

Analysis of the Bluff data indicates an annual reduction of approximately 9,200 acre-feet per year as a long-term linearized trend. This pattern is somewhat consistent with the data for the Colorado River Basin, discussed above; however, the reduction as a percent of the annual total is double that of the Colorado River (0.44 percent per year, versus 0.22 percent per year for the Colorado River) and reflects individual periods with declining flows (1920-1935 and after 1990). Although the year-to-year variability is substantial, the ongoing reduction in river flows at this site is clear. Individual yearly data are provided in **Appendix 3.2-A.**

<u>Seasonal Snowmelt Runoff</u>

As noted above, the annual total seasonal snowmelt and runoff in the Colorado River above Lake Powell, has been decreasing over the past century, but also has experienced a wide range of inter-annual variability. Data from Reclamation (2012) indicate that the gap between supply and use of Colorado River water has narrowed over the 20th Century, and the demand in recent years has exceeded the supply. The observed change in snowmelt, with earlier melting and peak runoff, has contributed to lower total water supply from this resource.

<u>Seasonal Rainfall Patterns</u>

The Southwest Monsoon precipitation pattern also has shown high year-to-year variability. A review of the monsoon precipitation in Tucson and Phoenix supports a conclusion that, precipitation (during the Monsoon season, as measured in southern Arizona) has neither generally increased nor decreased since 1895 (Guido 2009). However, the linear least-squares trend in data for Canyon de Chelly shows a decrease in total precipitation for July, August, and September of approximately 0.01 inch per year, meaning that the total Southwest Monsoon precipitation average at this site, is approximately 1 inch less than at the start of the 20th Century; however, this rate of decline is negligible compared to the year-to-year variability.

3.2.4 Environmental Consequences

3.2.4.1 Issues

3.2.4.1.1 Greenhouse Gases in the Atmosphere

GHGs in the atmosphere absorb the infrared radiation from the earth's surface and re-radiate that energy into the atmosphere and back to earth. GHGs include water vapor as a major, but locally variable, constituent along with seven basic compounds or groups that are well-mixed and not sensitive to local concentrations: 1) CO_2, 2) methane, 3) nitrous oxide, 4) hydrofluorocarbons, 5) perfluorocarbons, 6) sulfur hexafluoride, and 7) nitrogen trifluoride. Of these gases, only the first three are released by the NGS and proposed KMC operations and are relevant to depicting the existing environment for the Proposed Action. The data show the steady increase in the concentrations of these gases since the end of the 18th Century. Global GHG emissions from fossil fuel combustion and cement production was estimated to be approximately 35 billion metric tons in 2011 (IPCC 2013).

The trend and changes in atmospheric concentration and emission rates for these three compounds are the basis for evaluating the Proposed Action relative to climate change. GHGs are evaluated in terms of their global warming potential based on their CO_2-equivalent (CO_2e) effect on trapping infrared radiation in the atmosphere. CO_2e is calculated to represent the combined effect of a combination of GHGs using the concentration of each GHG multiplied by that gas' global warming potential, and calculating the sum of those multiples. The global warming potential for CO_2 is set at 1 as a comparative value. The mass-weighted global warming potential of methane is now set at 25 (i.e., one pound of methane emitted into the atmosphere has the same global warming potential as 25 pounds of CO_2, under this system), and the mass-weighted global warming potential of nitrous oxide is set at 295. Sulfur hexafluoride is a very powerful GHG and may be released by leaks from electricity distribution systems, but those effects were not evaluated as part of this analysis because none of the alternatives would make any substantial change in the electricity distribution system.

In the U.S., total emissions of GHG are estimated at 6,742 million metric tons of CO_2e (U.S. Environmental Protection Agency 2015). The peak U.S. emission rate was 7,450 million metric tons in 2007, with a reduction in 2013 of almost 10 percent from the peak year. Fossil fuel combustion accounted for 5,196 metric tons in 2013, or approximately 77 percent of the U.S. total GHG emissions for that year.

3.2.4.1.2 Air Quality

Air quality conditions have been improving over the recent decades, including in the U.S. Southwest; however some of the most adverse air quality conditions persist in the major urban areas (e.g., Los Angeles, Phoenix). As noted in Section 3.1.3, trends in air quality improvement have been noted in the region of the Proposed Action, and it is not certain if the changing climate at this time is contributing to impacts on human health or the environment because emission controls and other reductions in pollutant emitting sources have offset the effect of climate change.

3.2.4.1.3 Water Resources

Climate shifts, involving several centuries of wet or dry periods, have been documented in the U.S. Southwest by numerous investigations (e.g., Thornthwaite et al. 1942; Cook et al. 2004; Karlstrom 1988). In northeastern Arizona, the current drought cycle generally is thought to have begun in the mid-1990s (Redsteer et al. 2010). As described in Section 3.2.3, over the next several decades the regional effects of climate change are anticipated to include temperature increases (with considerable local variability), an increasing growing season length, and declining runoff volumes in the Colorado River Basin overall. Runoff declines are being exhibited currently in the study area.

As described in Section 3.7 (Water Resources), there typically are two peak periods for runoff: early spring and the late summer monsoon. Monsoonal moisture plays a major role in study region hydrology.

As mentioned earlier in this section, some investigations conclude that there are no precipitation trends in the North American Monsoon. Others indicate a positive precipitation trend (more rainfall) in in northern Arizona and western New Mexico, with a systematic delay in monsoon onset, peak period, and termination. As discussed in Section 3.2.3, local precipitation patterns at Canyon de Chelly show a slight reduction in total precipitation, both on an annual basis and for the regular monsoon season (July, August, and September) as shown in **Figure 3.2-8**. These variations are typical of local and regional precipitation conditions throughout the water resources study area, and lead to uncertainties regarding climate change and related water resources impacts. These primarily include (Reclamation 2016):

- Spatially downscaling climate model outputs from global scales to basin scales;
- Subsequently characterizing hydrologic responses in specific regions or basins to projected climatic changes, and;
- Definitively attributing individual hydrologic events (e.g., floods or droughts) at a particular place and time to the effects of climate change.

Water resources study areas for the project overlap the boundary between the Upper and Lower Colorado River basins (Reclamation 2016). Broadly regional climatic findings that apply to the impact assessment include (Reclamation 2016):

- Temperature increases are anticipated across the basin, with the largest changes in spring and summer. (This also will lengthen the growing season.);
- Springtime precipitation is expected to decline throughout the Colorado River Basin. Drying conditions also are projected during summer, although monsoon influences may create slight increases in precipitation for some areas of the Lower Basin;
- Streamflow changes (both surface runoff and channel baseflow components) will be diverse, but declines are generally expected; and
- Droughts lasting five or more years are projected to occur 50 percent of the time over the next 50 years.

Based on these factors, anticipated climate change impacts to deep aquifers in the study area (i.e., the D- and N-Aquifers) would be a gradual lowering of the piezometric surfaces in both aquifers due to reduced recharge. These impacts would be negligible through the year 2044 as well as over the subsequent period to 2110, which is included in groundwater modeling for the project. Groundwater analysis (Leake et al. 2016) estimates regional mean annual recharge for the N-Aquifer in the range of approximately 12,200 to 13,900 acre-feet per year (Water Resources **Appendix WR-10**). Mean annual recharge estimates for the D-Aquifer are approximately 5,400 acre-feet per year.

The reduction in regional mean annual recharge to these aquifers from climate change is uncertain due to the uncertainties identified above. Groundwater modeling simulations for the N-Aquifer suggest that it takes thousands of years for water levels to fully respond to recharge changes (Zhu et al. 1998). Ancient ice-age recharge rates (i.e., over 11,000 years ago) have been estimated to be two to three times higher than current rates; however, between 6,000 to 11,000 years ago, estimated recharge was about half what it is today (Zhu et al. 1998). On this basis, the N-Aquifer has undergone substantial past changes in recharge, but in timeframes of thousands of years. Over most of the study area, it would take much more time than is relevant to this project for climate change effects on N-Aquifer or D-Aquifer water levels to be evident. Because of this, climate change effects on D- or N-Aquifer water levels would be negligible over most of the study area. Similarly, changes to D- or N-Aquifer spring discharges or stream baseflows also would be negligible over most of the study area. One locale that could be an exception is the area around Shonto Wash and Tsegi Canyon. Much of the study area recharge occurs in this locale, and connected local discharge features (i.e., springs and stream baseflows) may decline over decades if warmer and drier conditions persist.

Shallower groundwater aquifers, including those in the Wepo and Toreva formations and streamlain alluvial deposits, are already exhibiting declines from drought over the past 20 years or so. These resources as well as related springs and seeps would undergo more pronounced impacts from anticipated future climate change. These aquifers are at or near the land surface over much of Black Mesa. On the mesa, local precipitation and drainage conditions have far greater influence over water levels in these aquifers than in the D- or N-Aquifers. If less precipitation continues to occur annually or seasonally, recharge to these aquifers would decline. These shallower zones support more extensive vegetation in canyons and washes, and that vegetation withdraws groundwater by transpiration. Warmer temperatures and a longer growing season would generate greater transpiration uptake by vegetation. As a result of these climate changes, water levels in these shallower aquifers would decline over decades, which would reduce associated spring flows and stream baseflows from the Wepo and Toreva formations or from connected stream alluvium and encourage the extent of deeper-rooted vegetation such as tamarisk. These impacts could lead to changes in biological habitats.

With respect to surface water resources, climate changes would reduce stream runoff and the amount of water retained in ponds and impoundments. Overall, lower precipitation rates would reduce rainfall runoff or snowmelt from the higher elevations. This would combine with greater temperatures and evaporation to reduce water levels and inundated areas in local ponds and impoundments as well as in Lake Powell. In small retention structures, evaporation would reduce the quality of water retained over long periods by removing water while leaving dissolved constituents behind. Over time, this would increase the concentrations of total dissolved solids and other constituents in these impoundments. Changes in the precipitation regime, such as lower overall precipitation but possibly more intense low-frequency storms, would interact with grazing and vegetation shifts to change erosion and sediment yield as well as the storage and transport of sediment through stream networks. These impacts would create additional instabilities in and near alluvial streams and river channels.

The responses of regional drainage systems to climate change are not well understood, particularly with respect to arroyos in alluvial valleys on the Colorado Plateau (Webb and Hereford 2001). A number of causes and effects are theorized in regional research. These primarily involve land use changes (particularly grazing), geomorphic processes that vary in time and space within individual drainages, and climate change responses. Arroyo downcutting on Black Mesa has been attributed to drought (Karlstrom 1988). In contrast, arroyo infilling across the region also has been attributed to drought (Hereford 2016). Most currently accepted theories emphasize climatic conditions as major factors for arroyo filling and cutting. Less emphasis is placed on grazing as a factor, due to stratigraphic studies that indicate ancient cycles of arroyo change centuries before European settlement.

Hereford (1989) suggests that reduced warm-season rainfall (June 15 through October 15) from the early 1940s through the 1970s contributed to sediment storage and floodplain development in Colorado River tributary channels. A reduction in the number of large floods during this drier period is believed to have contributed to this. Hereford et al. (2014) also found that the recent wet episode of the late 1970s to mid-1990s generated gully erosion of recent alluvial terraces in the nearby Grand Canyon. A suggested cause is that during intervening wet episodes, increased precipitation intensity generated greater runoff and fluvial erosion across a wide range of spatial scales (Hereford et al. 2014). Some of these impacts depend on El Niño Southern Oscillation intensity and frequency; Arizona typically has greater flood frequency during warm El Niño Southern Oscillation conditions (i.e., El Niño) (Webb and Hereford 2001). If the "ongoing Early 21st Century Drought beginning in the mid- to late 1990s" (Hereford et al. 2014) continues or intensifies, then arroyo infilling and floodplain formation likely would be encouraged by climate change across the study area. This could narrow the alluvial stream channels and provide opportunities for more extensive adapted vegetation.

3.2.4.1.4 Biological Resources Related to Climate Change

Climatic variation in the U.S. Southwest, as in any region, also is reflected by variations in land cover and land use (Section 3.14). Within the U.S. Southwest, the U.S. Gap Analysis Project mapped 209 ecological systems that are defined as groups of plant community types that tend to co-occur within landscapes with similar ecological processes, geology, soils, or ranges of environmental attributes such as elevation and precipitation (Fleishman et al. 2013). Most climate-based projections of species' distributions are based on an assumption of climate stability; however, the recently observed changes in climate indicate that shifts are occurring for some species in regions where climate change has been noted.

The discussions below provide a summary of observed changes in species, communities, and ecosystems that have been changing in response to changes in climate and climatic features such as evapotranspiration, temperature, and water supply. This discussion is not comprehensive, but gives an overview of selected species where changes have been noted. Changes in climate may be reflected in plants with the development of leaves, blooms, fish spawning, and migrations of birds. Changes in precipitation clearly affect soils, vegetation, and carbon storage in arid regions (Fleishman et al. 2013).

3.2.4.1.4.1 Aquatic Systems

Important aquatic resources within the project analysis areas include game fish and special status aquatic species that occur in Lake Powell and the Colorado River both upstream and downstream of the Glen Canyon Dam and the San Juan River. In particular, federally listed fish species (bonytail, Colorado pikeminnow, humpback chub, and razorback sucker) are present in Lake Powell, the Colorado River and San Juan River. Aquatic habitat is limited within the proposed KMC analysis area, therefore, few special status aquatic species are present (Section 3.13).

Based on information provided in **Figure 3.2-2** (Colorado River Runoff) and in Hoerling et al. (2013), increasing air temperatures and decreasing flows in the Colorado River have been documented. Temperature and water flow or volume are key components of habitat for aquatic species. Currently, the magnitude of global climate change is such that its effect on freshwater fisheries and other aquatic species could easily be masked by natural variability or attributed to other anthropogenic causes such as overexploitation, deforestation, and land use (Ficke et al. 2007). Global climate change appears to represent an additional stressor to a mixture of other factors including pollution, overfishing, water diversion, and wide-spread introduction of nonnative fishes.

The effect of increased water temperature on aquatic habitat and species could include changes in water quality (i.e., dissolved oxygen) and biological conditions such as direct mortality from acute temperature stress, sublethal stress on physiological functions, and shifts in species distributions (Ficke et al. 2007). Distribution range shifts for most groups of species, including aquatic species, are more difficult to attribute to changes in climate because the climate signal is small, there are many confounding factors, differences between expected and observed range shifts are large, or variability within or between studies is high. Changes in flow patterns or flow volumes could affect key biological activities such as fish spawning, early stage development of eggs and young fish, and increased colonization of nonnative or invasive aquatic species (Garfin et al. 2013). Higher air temperatures also may cause changes in food for fish by affecting invertebrate development (Garfin et al. 2013). In North America, the Intergovernmental Panel on Climate Change (IPCC 2014b) predicted that coldwater fisheries likely would be negatively affected, warmwater fisheries would generally be positively affected, and cool water fisheries would have a mixture of positive and negative changes in terms of habitat conditions and species distribution and diversity.

Climate change effects on amphibian species would be related to habitat factors and ecological requirements. As mentioned for fish species, temperature and precipitation changes could affect population abundance and distribution patterns. Other climate-related changes could include effects on survival, growth, reproduction, food availability, predator-prey relationships, and increased risk to disease

(Blaustein et al. 2010). Changes in ambient air temperature also may influence the timing of breeding and periods of hibernation. See Section 3.13, Special Status Aquatic Resources.

3.2.4.1.4.2 Agriculture and Forestry

Frisvold et al. (2013) summarize the observed changes in forests in the U.S. Southwest, concluding that increased temperatures along with periods of drought have led to the outbreak of pine bark beetles, which has led to high mortality among pinyon pines. Rapid mortality of mature aspen groves also has been attributed to drought, enhanced by warmer temperatures, and various combinations of insects and pathogens.

With warmer temperatures, fuel flammability in forests increases along with standing tree mortality, which increases the incidence of forest and woodland burned by wildfires. The total annual area burned in the U.S. Southwest has increased more than 300 percent since the 1970s.

Agriculture in the U.S. Southwest, particularly in arid regions, is heavily dependent on irrigation. Agricultural uses of water in the region account for 79 percent of all water withdrawals (Frisvold et al. 2013). The extensive surface water infrastructure supports this water storage and delivery system. Many locations are dependent on groundwater for irrigation. Depletion of the groundwater reserves and reductions in stream flow have presented increased costs for this sector. In some areas of northeastern Arizona, on the Navajo Nation lands, groundwater withdrawals supply over 75 percent of the total irrigation demand. Under warmer conditions, agricultural pests can persist year-round while new pests and diseases may become established.

3.2.4.1.5 Human Health

Topographical and climate variability in the U.S. Southwest is greater than any other region in the U.S. As a result, there is a wider range of vulnerability of human populations to any stress. Based on death certificates, an estimated 400 deaths per year are attributed to heat stress, and the largest number occur in Arizona. Records of heat related illnesses have been declining over the past years, largely due to increased air conditioning available to more of the population. However, this decline may not be true for tribal communities where there is a lack of infrastructure. There is no clear trend of human health conditions directly related to current changes in climate. The IWG on Climate Change and Health is targeting research efforts to establish direct links between climate change and research priorities related to human health categories considered likely to be affected by climate change.

3.2.4.1.6 Energy

Energy consumption in the U.S. Southwest has increased substantially since 2000, along with an increase in population. An important aspect of the changing climate is the peak use of electric power during the summer cooling season. Increasing temperatures and population have led to continued rapid increases in peak power demand in Arizona and other states.

A report prepared for the National Climate Assessment concluded that “Energy supplies will become less reliable as climate changes and climate change will drive increasing energy demand in some areas. Delivery of electricity may become more vulnerable to disruption due to extreme heat and drought events that increase demand for home and commercial cooling, reduce thermal power plant efficiency or ability to operate, reduce hydropower production, or reduce or disrupt transmission of energy” (Garfin et al. 2013).

Energy demand in the region outpaces production, leading to an increase in vulnerability of the regional electric power supply. Although current supply can meet the consumption through interstate transportation, under the current changing climate, the power generation sector is becoming more vulnerable to climatic effects such as increased temperatures (related to peak demand) and drought effects on hydropower production. Increased temperatures reduce the effectiveness of natural gas turbine power generation and increase power loss on transmission lines (summarized from Tidwell et al. 2013).

3.2.4.1.7 Socioeconomics

Section 3.18.4 presents the major income and fiscal benefits of the Proposed Action and alternatives that would accrue in the region. However, it does not estimate many other economic effects such as the value of providing reliable, low cost electricity for NGS utility customers, including the Central Arizona Project; the economic contributions to current domestic production from use of that electricity; or long-term benefits provided by capital investment in housing and commercial and public infrastructure supported directly and indirectly by the direct income and tax benefits. Addressing such effects is not within the scope of a site-/project-specific assessment such as the current effort. Section 3.18.4 acknowledges that there also may be public and social costs associated with each alternative. Potential costs would include the SCC associated with contributions in global CO_2 emissions from NGS and alternative sources that would result from implementation of the Proposed Action and alternatives.

A changing climate poses challenges to the global social and economic structure as well as potential impacts on the natural environment. Climate change has the potential to affect most aspects of the socioeconomic environment including economic conditions, population migration and settlement patterns, housing, public infrastructure and services, and fiscal and social conditions. In addition, a location's specific physical, economic, social, and cultural setting can intensify or dampen the socioeconomic effects of climate change. For example, communities with more abundant and diverse fiscal, natural and infrastructure resources may be more able to implement adaptation strategies to lessen climate change effects.

The three NGS generating units are among the 552 power plants and major sources (units) nationwide that collectively emit approximately 1.57 billion tons of CO_2. NGS emissions were approximately 1 percent of the total CO_2 emissions from those power plants and major sources. However, information regarding the timing, type, magnitude, and scale of climatic changes that would be associated with future emissions under the Proposed Action and the subsequent effects of those changes on local social and economic conditions are not available. Consequently, the discussion of socioeconomic effects focuses on the anticipated effects of climate change in general during the assessment period (2020 to 2044).

Socioeconomic conditions that may be affected by climate change include the availability and reliability of water for domestic, agricultural, municipal and industrial uses, and to sustain surface water features such as seeps, wetlands, rivers, streams, lakes and reservoirs. In addition to providing water for human use, these water features support plant and animal life, tourism, and outdoor recreation and comprise an important amenity value for residents and visitors alike. Temperature and precipitation-related changes in vegetation also can positively or negatively affect wildlife, tourism, outdoor recreation, food production, public infrastructure, and the livability of an area. Wildfires, floods, and extreme weather events also can affect socioeconomic, conditions.

3.2.4.1.7.1 Regional Economic Base of Northeastern Arizona

Key economic drivers in northeastern Arizona include tourism and outdoor recreation; government (federal, state, Tribal, and local); manufacturing; health care; science and research development; agriculture; coal mining; electric power generation; and transportation. Although the majority of these activities are indirectly sensitive to climate change, agriculture, tourism, and outdoor recreation are particularly sensitive to the potential effects of climate change. Some of the sensitivities of these sectors to climate are described below.

<u>Agriculture and Livestock</u>

Agriculture is a small but relatively important segment of the study area's economic base and socioeconomic environment. As with other areas of the U.S. Southwest, agriculture in the study area is heavily dependent on groundwater for irrigation. On the Navajo Nation lands, groundwater withdrawals supply over 75 percent of the total irrigation demand. Depletion of the groundwater reserves and reductions in stream flow have resulted in increased costs for this sector. Under warmer conditions, agricultural pests can persist year-round while new pests and diseases may become established. Water also is important for livestock. With the decrease in the number and flow rates of springs and other surface water described above, many Navajo presently haul water for their livestock.

Tourism and Outdoor Recreation

Tourism, outdoor recreation, and the associated hospitality/leisure industry are among the main drivers of the Coconino County economy, and a variety of businesses in the county are dependent on the natural environment (Coconino County 2015b). Tourism and recreation also are principal industries of the Navajo County economy (Navajo County 2011). The Navajo Nation 2015 to 2019 Navajo Tourism Strategic Plan concludes, “there are significant gains to be made by more heavily relying upon tourism development as a vital component of economic development activities throughout Navajo Nation” (Navajo Tourism Department 2015).

While some assessment of the effects on tourism from climate change is underway, such effects cannot be singled out from assessment of the global economic and socioeconomic response to climate change (United Nations World Trade Organization). Tourism is a climate-dependent industry, and many destinations owe their popularity to their pleasant climates during traditional holiday seasons (Amelung et al. 2007). Current literature also does not provide a clear review of any changes to tourism in the region currently resulting from climate change.

Tourism and outdoor recreation can be affected by extreme temperatures, drought, flooding, declines in river flows and other surface waters, changes in ecosystems, vegetation and land cover, wildland fires, and changes in the seasonal timing and duration of events relative to vacation, school, and holiday schedules as well as other factors that affect travel and recreation participation.

3.2.4.1.7.2 Public Water Supplies

Public water supplies can be directly and indirectly affected by drought and a changing climate. Within the study area, the City of Page, some communities on the Navajo Nation, and the NGS obtain water from the Colorado River. Although other surface water resources are used, most water in the region is obtained from groundwater. Groundwater is the most heavily utilized and dependable municipal water source for the Navajo Nation, particularly for those communities served by the Navajo Tribal Utility Authority (2015). Municipal use of reclaimed water for non-potable purposes is increasing (Coconino County 2015a).

As described in Section 3.18, many rural Navajo do not have residential water service and must haul water from chapter or privately operated wells. Flagstaff draws water from a reservoir and groundwater. Reservoir levels have been variable as a result of drought conditions that began in the 1990s, causing the city to be increasingly reliant on groundwater resources (Coconino County 2015a). Throughout the region, surface water features have been diminishing as a result of the drought and changing climatic conditions (Redsteer et al. 2015).

3.2.4.1.7.3 Sociocultural

Native Americans living within the U.S. Southwest are particularly vulnerable to the effects of climate change (Redsteer et al. 2013). Agriculture (grazing and small scale farming) is particularly important for many rural Navajo and Hopi families to provide basic components of their diet, as a traditional cultural activity, and in some cases, as a means to supplement their incomes. Population growth and relocation have resulted in competition for grazing land and, in some cases, water. Poverty limits the ability to develop and implement climate-related adaptation measures (Redsteer et al. 2013). As described in the following sections, recent research has furthered the understanding of the effects of climate and drought on the Navajo Nation and Hopi Tribe.

Navajo Nation

Many Navajo raise livestock and engage in small-scale farming and herb gathering for subsistence to maintain cultural traditions and to supplement their income. Population growth on the Navajo Nation over the last century and relocation of thousands of Navajo families associated with the passage and implementation of the 1974 Navajo-Hopi Land Settlement Act, as amended in 1980, resulted in competition for grazing lands and water and, in some cases, overgrazing on Navajo grazing lands. Changes in traditional grazing practices resulting from stock reduction programs and federally imposed grazing restrictions beginning in the 1930s limited the Navajo traditional drought adaptation practices of relocating livestock to an extended family's customary use area with more favorable conditions during times of drought (Redsteer et al. 2015).

In a study conducted on the Navajo Nation, 73 tribal elders were interviewed to refine the understanding of the effects of climate change on Navajo traditions, culture, and wellbeing, and to determine how these effects are magnified by historic changes in land tenure policies and economic conditions. Navajo elders who participated in the study reported a long-term decrease in snowfall in the latter half of the 20th Century, a decline in surface water features and water availability, springs and lakes drying up, and ephemeral washes and rivers flowing less often. Although all ecosystem impacts could not be attributed to changes in snowpack and increasing temperatures, the study concluded, "…changes to religious practices, farming, plants, animals, and water supplies have certainly been affected by a drying climate. Already dire conditions of increasing population pressures, poor socioeconomic conditions, and a limited resource base have acted in combination with climatic change to push the viability of living on Navajo land to its limit" (Redsteer et al. 2015).

Specific conclusions of the study include the following:

- "Climate change impacts have contributed significantly to poor living conditions on Navajo reservation lands. This region is characterized by harsh, dry conditions and sparse water supplies, even during normal conditions, and therefore is more vulnerable. The relocation of Navajo families from land allocated to the Hopi tribe has placed additional strain on local resources by increasing population pressures.
- Dire economic conditions and cultural ties to livestock add land use stresses that create greater risk and vulnerability from drought impacts and climate change.
- Lack of available water has undermined the ability of Navajo people to grow corn and other crops, and to collect corn pollen. Corn pollen is used for blessings and is central to every Navajo prayer and ceremony.
- Changes in springs, and plant and animal species have left ceremonialists without many of the resources necessary for traditional Navajo prayers, ceremonies, and offerings" (Redsteer et al. 2015).

Hopi Tribe

Corn is considered a cultural keystone species for the Hopi Tribe because of its importance in their diet, traditional values and cultural life. Hopi use labor-intensive dry farming methods to raise corn, one relying exclusively on precipitation and runoff rather than irrigation. Gardening also is culturally important for many Hopi, and Hopi gardens used to grow vegetables other than corn traditionally are irrigated by springs. Produce grown in Hopi gardens typically is consumed by the gardener's household and not sold (Rhodes 2013).

In a study on the Hopi Reservation, 35 elders, government employees, farmers, gardeners, ranchers, and others were interviewed on the topic of drought in order to understand Hopi perspectives on the causes of drought, to catalog Hopi people's observations of drought, to describe the negative impacts of drought, and to document current and proposed adaptation strategies for lessening those impacts. There was consensus among study participants that less overall rainfall was occurring, the timing of rainfall had shifted to later in the summer, and the pattern of rainfall was more patchy and unpredictable than in the past. Participants also reported less snowfall and a change from wet to powdery snow. Springs, which are an important source of water for household use, gardening, and for ceremonial use, also were reported as declining in terms of flow rates or disappearing altogether. Participants reported that the quantity and quality of vegetation had been affected by drought and cited a decline in native plants, the increasing pressures of non-native species, and overall poor range quality, all of which were generally attributed to a combination of dryness and overgrazing (Rhodes 2013).

Although individual Hopi farmers are implementing adaptive strategies, the most serious direct impact of drought on Hopi farming are lower yields or complete loss of the annual corn crop. As a cultural keystone species for the Hopi people, corn's "absolute centrality in the Hopi worldview, spiritual beliefs, diet, ceremonies, and life events makes it culturally more important than any other plant or animal species. Furthermore, because of the ubiquity of corn in the Hopi diet, the ability to procure Hopi varieties of corn through traditional methods – that is, farming – is a cornerstone of cultural food security for the Hopi people" (Rhodes 2013).

3.2.4.1.7.4 Socioeconomic Considerations in Central and Southern Arizona

The electrical supply provided by NGS creates an indirect socioeconomic linkage between the primary study area and areas in central and southern Arizona served by the CAP. Those areas include 10 Indian reservations; water utilities and districts; and agricultural interests in Maricopa, Pinal, and Pima counties. Between 1985 and 2010 the combined population of Maricopa, Pinal, and Pima counties more than doubled to 5.17 million residents, and more than 1.34 million net jobs were added (U.S. Bureau of Economic Analysis 2014). Between 2000 and 2010, the Maricopa County population grew by 24 percent, Pima County population grew by 16 percent, and Pinal County population increased by 109 percent. Together the three county area added a total of almost 1.1 million people between 2000 and 2010 (**Table 3.18-21**). As noted in Section 3.18.3.3, water availability, much of which is supplied by CAP, has been critical to the economic expansion and population growth of central and southern Arizona.

Additionally, the CAP system delivers approximately 1.6 million acre-feet of Arizona's Colorado River water entitlement. CAP supplies approximately 50 percent of the municipal water demand within Maricopa, Pima, and Pinal counties including 43 percent of the Phoenix supply and approximately 80 percent of the Tucson municipal water supply (CAWCD 2014). CAP water deliveries accounted for approximately 30 percent of statewide municipal and industrial water deliveries and 11 percent of water used for agriculture between 2007 and 2009. CAP supplies water for 21 percent of total farms and 16 percent of total agricultural acres in the state (Section 3.18.3.3). Contributions to the statewide gross domestic product associated with those deliveries was estimated to account for 32 percent of the total statewide gross domestic product during that same period (Seidman Institute 2014).

Given that the CAP obtains its water from the Colorado River, the decreasing Colorado River flow trend described in Section 3.2.3.1 and potential Stage I water shortage that could occur in 2016 (see Prospect of Stage I Water Shortages on the Colorado River subsection in Section 3.18.3.3), it is possible that CAP water deliveries would be reduced by 320,000 acre-feet per year.

If the shortage persists, fixed system costs would need to be absorbed by lower delivery volumes, potentially requiring rate increases. CAP's pumping energy requirements, along with the associated energy and transmission costs, would decline and potentially increase the availability of excess energy for sale. In the event of a more severe Stage II shortage, that would reduce CAPs annual allocation by an additional 80,000 acre-feet, the CAP plan would further curtail deliveries to the agricultural pool, while preserving the deliveries to priority customers. In addition to requiring further rate increases, regional economic output would decline as a result of the 400,000 acre-feet cutback in water deliveries (CAWCD 2015).

3.2.4.1.8 Social Cost of Carbon—Global

As an existing operation, future CO_2 and GHG emissions from NGS and the Kayenta Mine through the end of 2019 would contribute to global climate conditions. Although monetized values could be assigned to those emissions under the concept of the Social Cost of Carbon, those values would have limited meaning due to their low relative magnitude within a global context (USEPA 2016). However values for the EIS alternatives are presented for comparison purposes, from a Social Cost of Carbon perspective in the remainder of this section.

3.2.4.2 Assumptions and Impact Methodology

The environmental consequences of the Proposed Action and alternatives would take place in an era of a changing global climate. The consequences of any one action, even a major action, on global climate are impossible to predict; however, the predicted future of global and regional climate change is important to understand along with how the Proposed Action and alternatives are affected by the changing climate. This section provides an overview of the projected changes in global and regional climate, which serve as a backdrop for reporting magnitudes and relative contributions of the estimated GHG emissions of the Proposed Action and alternatives for the period 2020 to 2044. Comparative estimates of SCC associated with changes in operations of NGS and the Partial Federal Replacements (PFRs) also are presented.

3.2.4.2.1 Future Temperature Trends—Global and Regional

Various climate models have provided a wide range in predictions of global surface air temperature over the next decade. The IPCC (2013) report summarizes details of temperature and precipitation changes resulting from an array of global and regional atmospheric circulation models. A consensus was built around the results of multiple models that were run with a range of predicted increases in CO_2 emissions. Results have been developed for both a 3-Unit Operation and 2-Unit Operation, with the presumption that actual impacts would be within the predicted ranges.

While the Arctic region is predicted to receive the greatest increase in annual temperature, the western and southwestern portions of the U.S. also are regions where predicted increases in temperature are notable (**Figure 3.2-10**). Northern Arizona may experience up to 2°C annual average increase by mid-century under the low global emissions scenario and potentially up to 4°C under the high global emissions scenario (IPCC 2013). Based on a summary of model impacts (Cayan et al. 2013) as demonstrated for the different emissions scenarios in **Figure 3.2-10**, regional temperature increases could range from 2°C to approximately 5°C by the late 21st Century.

According to IPCC (2013), global warming of approximately 2°C (above the pre-industrial baseline) is very likely to lead to more frequent extreme heat events and daily precipitation extremes over most areas of North America, more frequent low snow years, and shifts towards earlier snowmelt runoff over much of the western U.S. and Canada (IPCC 2013). Together with climate hazards such as higher sea levels and associated storm surges, more intense droughts, and increased precipitation variability, these changes are projected to lead to increased stresses to water, agriculture, economic activities and urban and rural settlements. **Figure 3.2-10** (IPCC 2013) predicts an increase in temperature of 2°C or more for the U.S. Southwest by the middle of the 21st Century.

Global warming of approximately 4°C is very likely to cause larger changes in extreme heat events, daily scale precipitation extremes and snow accumulation and runoff, as well as emergence of a locally novel temperature regime throughout North America (IPCC 2013).

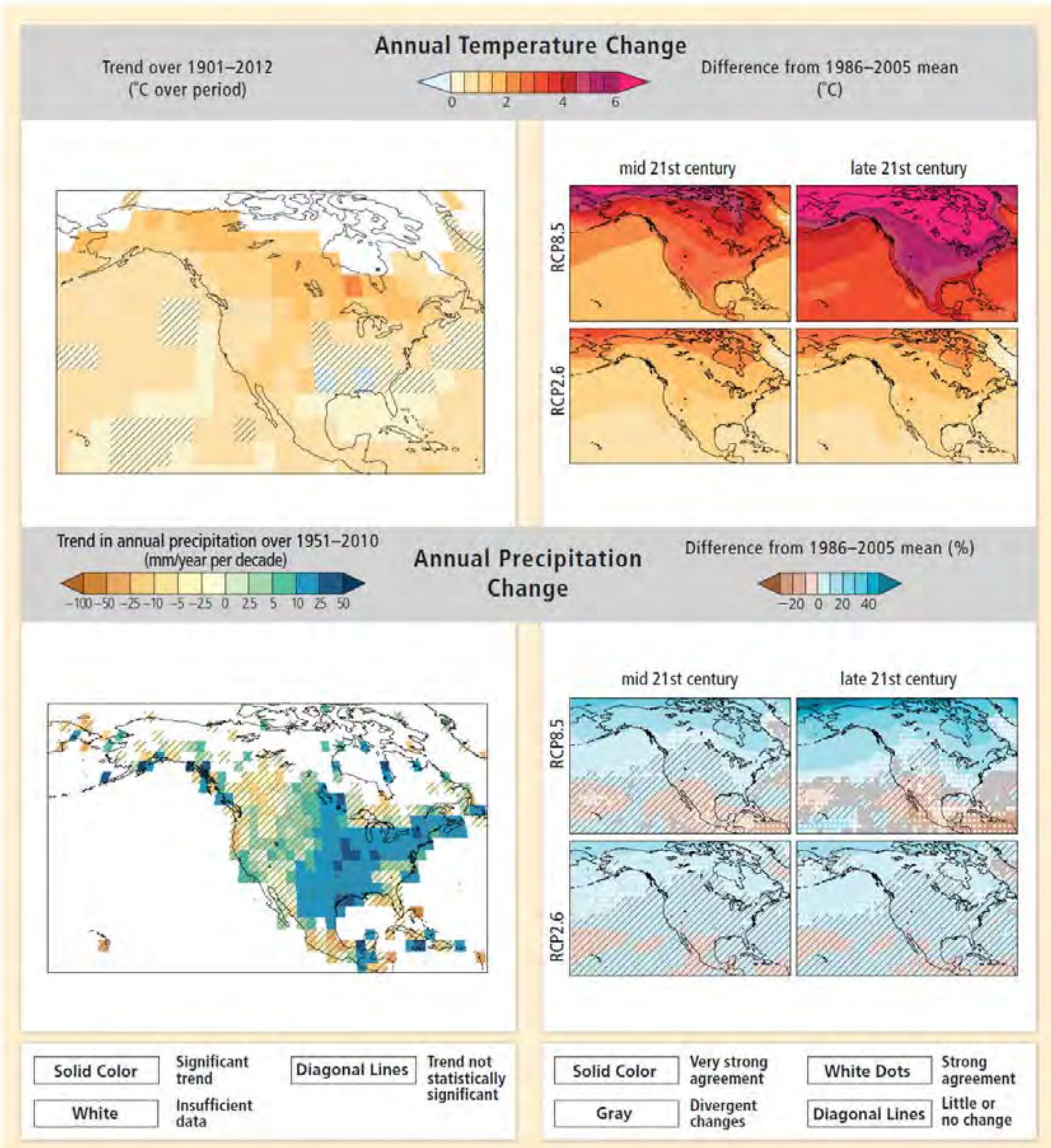


Figure 26-3 | Observed and projected changes in annual average temperature and precipitation. (Top panel, left) Map of observed annual average temperature change from 1901–2012, derived from a linear trend. [WGI AR5 Figures SPM.1 and 2.21] (Bottom panel, left) Map of observed annual precipitation change from 1951–2010, derived from a linear trend. [WGI AR5 Figures SPM.2 and 2.29] For observed temperature and precipitation, trends have been calculated where sufficient data permit a robust estimate (i.e., only for grid boxes with greater than 70% complete records and more than 20% data availability in the first and last 10% of the time period). Other areas are white. Solid colors indicate areas where trends are significant at the 10% level. Diagonal lines indicate areas where trends are not significant. (Top and bottom panel, right) CMIP5 multi-model mean projections of annual average temperature changes and average percent changes in annual mean precipitation for 2046–2065 and 2081–2100 under RCP2.6 and 8.5, relative to 1986–2005. Solid colors indicate areas with very strong agreement, where the multi-model mean change is greater than twice the baseline variability (natural internal variability in 20-yr means) and ≥90% of models agree on sign of change. Colors with white dots indicate areas with strong agreement, where ≥66% of models show change greater than the baseline variability and ≥66% of models agree on sign of change. Gray indicates areas with divergent changes, where ≥66% of models show change greater than the baseline variability, but <66% agree on sign of change. Colors with diagonal lines indicate areas with little or no change, where <66% of models show change greater than the baseline variability, although there may be significant change at shorter timescales such as seasons, months, or days. Analysis uses model data and methods building from WGI AR5 Figure SPM.8. See also Annex I of WGI AR5. [Boxes 21-2 and CC-RC]

Source: Reproduced from IPCC 2013.

Figure 3.2-10 Observed and Predicted Changes in Annual Average Temperature and Annual Precipitation

The observed and predicted increase in surface temperatures also would have an effect on the length of the local growing season. Cayan et al. (2013) predict that the average growing season length would increase by 24 to 31 days per year for the period 2041 to 2070 when compared to 1971-2000. This projection would result in an ongoing trend in the increase in the length of the growing season by approximately 1 day every 3 years. The effect may differ within the different climate areas, even within the Navajo Nation and Hopi Reservation lands, but there is confidence that the length of the growing season likely would increase.

3.2.4.2.2 Model Precipitation Predictions

Predicted change in regional precipitation is less clear than for regional temperatures for the 21st Century. The Proposed Action is in a region where the model predictions are not clear and are not statistically significant, as shown in **Figure 3.2-10.** Northern Arizona is in the area where a near-zero change in percent of annual precipitation is predicted. For higher emissions, the models predict a slight (0 to 10 percent) increase in annual precipitation in the region; however, that increase is determined to be not significant (IPCC 2013). The IPCC panel indicates low confidence in determining a trend in precipitation that is associated with changing climate. Any trend in precipitation is generally very small in comparison to the variability in the historical record and in comparison to the variability among the model results (Cayan et al. 2013).

The discussion of predictions in climate change is intended to show how local changes are occurring, and to the extent available, understand how a changing climate affects water supply and other resources that are analyzed in this EIS.

Over the U.S. Southwest, the prediction related to the primary seasonal precipitation features is less clear. Most models predict an increase in winter precipitation (i.e., December, January, and February) with a slight tendency for reduced precipitation in other seasons (Cayan et al. 2013). However, the precipitation pattern includes a projection of more rainfall and less snow, resulting in lower spring snowpack levels, earlier snowmelt, and a reduction in late-spring and summer runoff from mountainous areas. Projected Colorado River flows are expected to show possible reduction from climate change impacts ranging from approximately -5 percent to -20 percent of the current annual flow by mid-century.

There is a weak level of consensus about predicted changes in the Southwest Monsoon circulation, which reflects the challenge of representing the monsoon circulation in a global atmospheric model (Cayan et al. 2013). The interannual variability of the monsoon precipitation is partially dependent on the large scale features such as the El Niño Southern Oscillation and the Pacific Decadal Oscillation; however, the global circulation models exhibit large uncertainty in predicting these features. Furthermore the precipitation during the North American Monsoon is dependent on fine scale features, including thunderstorms and convective activity. Therefore, the ability to predict the nature of the precipitation patterns related to the North American Monsoon is very low.

IPCC (2013) provides a consensus that there is low confidence in projections of precipitation changes for the North American Monsoon, but medium confidence that the North American Monsoon will arrive and persist later in the annual cycle.

3.2.4.2.3 Global GHG Levels and Emissions

Stocker et al. (2013) provides a technical summary overview of GHG levels in the atmosphere, and indicates that by 2035, global average CO_2 concentrations will range between approximately 425 ppm and 500 ppm. Total annual fossil-fuel carbon emissions projected for 2040 are approximately 43 billion metric tons (43 X 10^{15} grams), which is up from an estimated 34 billion metric tons in 2015 (Statista 2016).

3.2.4.2.4 Social Cost of Carbon

In the context of this NEPA assessment, the federal SCC concept "…is an estimate of the monetized damages associated with an incremental increase in CO_2 emissions in a given year.[1] SCC estimates are intended to include (but are not limited to) changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services due to climate change." One purpose of SCC estimates is to allow agencies to incorporate values for the social benefits of reducing CO_2 emissions (sometimes referred to as avoided damages) into cost-benefit analyses of regulatory actions that impact cumulative global emissions (IWG on SCC 2015).

The annual emissions of CO_2 associated with NGS and the PFR alternatives, prepared as part of this analysis (Section 3.2.4) and expressed in metric tons per year (tpy), are multiplied by the federal SCC per metric ton values developed by the IWG on SCC and discounted to a present value.[2] Those values reflect averages of the results produced by three integrated assessment models discounted to present values using discount rates of 2.5, 3, and 5 percent. The series of discounted annual values are then summed to obtain a total value for the period 2020 through 2044, which is the assumed operating life of the NGS under the Proposed Action and alternatives.

The estimated SCC values associated with a metric ton of carbon emissions used in this assessment are presented in **Table 3.2-1**, and those values were used to calculate the projected SCC for the Proposed Action and each of the alternatives. The presentation of multiple discount rates recognizes uncertainty regarding the appropriate discount rate for long-term changes that would span multiple generations.

Table 3.2-1 Estimated Social Cost of Carbon

Year	SCC Value for Discount Rate (2015 USD/Metric ton CO_2)			95th Percentile / 3% Discount Rate
	5.0% Rate	3.0% Rate	2.5% Rate	
2020	14	49	75	148
2025	16	55	81	166
2030	18	60	87	183
2035	22	66	93	202
2040	24	71	100	221
2044	26	75	105	233

Note: 2015 values are 2007 values inflated by 1.15 based on changes in the Consumer Price Index.

USD = U.S. dollars.

Source: IWG on SCC 2013; U.S. Bureau of Labor Statistics 2016.

The IWG on SCC (2015) also published a fourth set of SCC values. Those values, termed the 95th percentile at a 3 percent discount rate (95^{th} / 3 percent) in reference to the statistical construct it represents, are intended to capture virtually the entire range of high and low values of the long-term results produced by 45 scenarios evaluated by the three integrated assessment models. The 95^{th} / 3 percent value is considerably higher than the other three sets of values as it accounts for higher

[1] The term "monetized" refers to estimates of the economic values of costs or benefits, expressed in terms of an equivalent monetary value, that are not expressly quantifiable or observable through normal market transactions. For example, although entry and use of wilderness typically carries no entry fee, a study of 20 empirical studies of the economic value of recreation in wilderness reported an average value of $39 per recreation day (Loomis 2000).

[2] Per the draft CEQ guidance, the SCC analysis is based on tons of CO_2 emissions rather the broader CO_2e, or CO_2 equivalents.

degrees of uncertainty regarding the incremental damages to physical and economic systems that become more stressed in response to climatic change over the long-term (IWG on SCC 2015).

The IWG has acknowledged serious challenges and inherent limitations in assessing the incremental economic impacts of CO_2 emissions, recognizing that a "number of key uncertainties remain" and that current SCC estimates should be treated as provisional and revisable because they will evolve with improved scientific and economic understanding. The federal estimates of SCC also are the subject of ongoing review and critique. For example, a 2014 technical assessment of the SCC recommended that the current experimental design using three divergent models be revisited, and that additional guidance be provided on the proper use of SCC to avoid misapplication. The study further concluded that "…SCC estimates are difficult to interpret, discuss, and evaluate in terms of the societal risks they do and do not represent…" (Rose et al. 2014).

3.2.4.3 Proposed Action

3.2.4.3.1 Emissions

3.2.4.3.1.1 Navajo Generating Station

The GHG emissions from the Proposed Action primarily are related to the combustion of coal at NGS, and this is directly related to the level of power production in each of the Proposed Action operations. Results have been developed for both a 3-Unit Operation and 2-Unit Operation, with the presumption that actual impacts would be within the predicted ranges. A rough estimate of GHG emissions from NGS operations also is provided, based on estimates of fuel use and oil combustion. Predicted GHG emissions are provided in **Table 3.2-2**, both for CO_2e and CO_2, and backup calculations are provided in **Appendix 3.2-C** Exhibit 1. The estimates are based on an annual 88 percent capacity factor, and use the following assumed conversion factors (from 40 CFR Part 98 Tables C-1 and C-2, and Subpart A), and the heat rate data provided by NGS.

- 93.28 kilograms CO_2 per million British Thermal Units of coal combustion.
- 0.011 kilograms methane per million British Thermal Units of coal combustion, CO_2e weight of 25.
- 0.0016 kilograms nitrous oxide per million British Thermal Units of coal combustion, CO_2e weight of 298.
- Gross NGS heat rate of 11,194 British Thermal Unit/kilowatt-hour, or 11.194 million British Thermal Units/megawatt-hour.

Table 3.2-2 GHG Emissions from NGS for the Proposed Action

	3-Unit Operation	2-Unit Operation
NGS Generation (megawatt [MW], 88 percent capacity factor)	1980	1320
Annual CO_2e Emissions (metric tons)		
NGS Generation	18,257,000	12,171,000
NGS Support Operations	130,000	130,000
Total Rounded	18,387,000	12,301,000
Annual CO_2 Emissions (metric tons)		
NGS Generation	18,111,000	12,074,000
NGS Support Operations	129,000	129,000
Total Rounded	18,240,000	12,203,000

The Black Mesa & Lake Powell Railroad is operated on electric power provided by NGS; therefore, it has no additional GHG emissions except for fuel burning equipment that provides routine and emergency maintenance and repair.

3.2.4.3.1.2 Proposed Kayenta Mine Complex

Methane may be released from surface coal mining operations, including emissions from mining and coal handling. Kirchgessner et al. (2000) estimated methane content from coal mined from western surface coal mines at 0.17 pound per ton of coal. Given the approximate coal mining for the 8.1 million tpy Operation, the total methane released during mining, handling storage, or processing is estimated to be 689 tpy. With methane's global warming potential of 25, this equates to 15,600 metric tons of CO_2e. For the 5.5 million tpy Operation, an estimated 468 tpy of methane would be emitted. This equates to 10,600 metric tons of CO_2e.

Fuel use for mining operations, including diesel-fired mining equipment, vehicle traffic, and hauling operations at the proposed KMC, was based on an estimated 5.4 million gallons of diesel fuel for the operating equipment for the 8.1 million tpy Operation. For the 5.5 million tpy Operation, estimated annual fuel use would be 4.2 million gallons of diesel fuel for the operating equipment. That analysis uses diesel fuel emissions data from 40 CFR Part 98 Tables C-1 and C-2, and an assumed sulfur content of 15 parts per million by volume along with the projected equipment SO_2 emissions for the proposed KMC operations. Detailed backup calculations are provided in **Appendix 3.2-C**, Exhibit 2.

Table 3.2-3 provides a summary of total GHG emissions from coal mining operation based on a prorated coal production level.

Table 3.2-3 GHG Emissions from Proposed KMC for the Proposed Action

Proposed KMC Total Coal Production (million tpy)	Emissions (metric tpy in CO_2e)		
	Methane	Equipment	Total
8.1	15,600	55,300	71,000
5.5	10,600	43,400	54,000

The table includes GHG (methane) emissions from coal mining and production GHG emissions from proposed KMC operations.

The range for configuration is provided for each operation, based strictly on the coal production at proposed KMC. This level of annual production was calculated to meet the power generation.

3.2.4.3.1.3 Transmission Systems and Communication Sites

Except for the GHG emissions from maintenance operations and incidences of on-site emergency power generation (less than 10 metric tons annually), there would be no other GHG emissions associated with the transmission lines and communication sites (**Appendix 3.2-C**, Exhibit 3). The transmission system and communication sites would have no effect on GHG emissions because there would be a very small amount generated during future operation and maintenance. The effects of natural variability in climate conditions would be greater than any projected change in climate conditions related to these operations.

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

No new construction is proposed for the transmission lines and activities along the lines would be limited to routine and periodic major maintenance. Consequently, future climate change effects on these facilities and activities likely would be limited to the increased potential for damage associated with extreme weather events and wildfires, which could require additional maintenance or reconstruction of transmission lines and communication sites. The impacts of such events likely would be localized, short-term, and unpredictable in occurrence and intensity.

3.2.4.3.1.4 Project Impact Summary – All Project Components

Table 3.2-4 provides a summary for all project emissions from NGS and proposed KMC. Emissions from transmission lines and communication sites would be negligible.

Table 3.2-4 Total Project GHG Emissions for Proposed Action and Contribution to Projected Global Emissions in 2040

NGS Operation	Emissions (tpy in CO_2e)			Fraction of Global CO_2e Emissions in 2040 [1]
	NGS	Proposed KMC	Total Proposed Action	
3-Unit Operation	18,387,000	71,000[2]	18,458,000	0.00026
2-Unit Operation	12,301,000	54,000[3]	12,355,000	0.00018

[1] Calculated from Organisation for Economic Cooperation and Development (2011) 70 Giga-tonnes/year (70×10^{15} g).

[2] Value represents 8.1 million tpy coal production.

[3] Value represents 5.5 million tpy coal production.

3.2.4.3.1.5 Cumulative Impacts

The combined NGS and Kayenta Mine operations released approximately 20 million metric tons of CO_2e during 2014, which is approximately 0.055 percent of the total global GHG emissions and 0.28 percent of the total U.S. GHG emissions.

There are a variety of estimates for future increases in global GHG. One example (Organisation for Economic Cooperation and Development 2011) estimates 52 giga-tonnes of GHG would be emitted, with an increase to 80 giga-tonnes by 2050 (**Table 3.2-5**). The total GHG emissions for the project from all operations were compiled for the Proposed Action and would range from a high of 18,336,000 metric tons annually for the 3-Unit Operation to a low of 12,266,000 metric tons annually for the 2-Unit Operation. GHG contributions for NGS for the operating period of 2020 to 2044 were compared to the GHG global estimated increases. The Organization for Economic Cooperation and Development data projects an 80 percent increase in global energy demand, driven largely by major emerging economies and including a strong demand for vehicles and their resultant emissions. Cumulative global CO_2e emissions would increase by 52 percent from 2020 to 2050, a major impact (**Table 3.2-5**). The trend data show that NGS would contribute a declining percentage of global GHG because NGS emissions would remain relatively constant through this operating period.

Table 3.2-5 Total Proposed Action Contribution to Global GHG Emissions

Operation	3-Unit Operation	2-Unit Operation
	(Metric Tons of CO_2e) [1]	
Total Project Emissions – Proposed Action	18,458,000	12,355,000
Proposed Action Fraction of Global CO_2e (52 giga-tonnes in 2020) [2]	0.00035	0.00023
Proposed Action Fraction of Global CO_2e (61 giga-tonnes in 2030) [2]	0.00030	0.00020
Proposed Action Fraction of Global CO_2e (70 giga-tonnes in 2040) [2]	0.00025	0.00017
Proposed Action Fraction of Global CO_2e (80 giga-tonnes in 2050) [2]	0.00023	0.00015

[1] Data rounded to nearest 1,000.

[2] Data from Organisation for Economic Cooperation and Development (2011). giga-tonne = 10^9 metric tonnes = 10^{15} g.

3.2.4.3.2 Socioeconomics

While acknowledging the uncertainty associated with predicting the effects of future climate changes on the environment and society, Garfin et al. (2013) concluded with medium-high confidence that a large portion of the U.S. Southwest, including most of the region's major river systems such as the Colorado River, would be expected to experience reductions in stream flows and other limitations on water availability in the 21st Century. Overpeck et al. (2013) concluded with high confidence that water availability could be decreased even more by unusually warm, decades-long periods of drought. Reclamation (2016) confirmed that, absent future action, the basin faces a wide range of plausible future long-term imbalances between supply and demand, ranging from 0 to 6.8 million acre-feet per year. The effects of such reductions would include decreased availability and reliability of water for domestic, agricultural, municipal, and industrial uses as well as decreased flow and an increased rate of disappearance of some surface water features such as springs and seeps.

Warming temperatures, potential changes in precipitation patterns, and the resultant effects on the physical and biological environment described in the preceding sections likely would result in a continuation and intensification of the recent effects on socioeconomic resources described in Section 3.2.4.1.

Population growth in the region is forecast to continue to grow through 2050 (Section 3.18.3.3). It is unknown whether and how climate changes would affect future growth. If the population continues to increase as currently forecast, demand for water, energy, and infrastructure would increase with population growth and the associated economic expansion. Rising temperatures, increases in wildfire (Fleishman et al. 2013), heat waves, and floods (although there is some uncertainty about the latter) (Gershunov et al. 2013) could affect the cost of living and the cost of providing public services including water and wastewater infrastructure in the affected areas. Rising temperatures also may increase energy demand, stressing existing energy generation and distribution systems and requiring additional generating facilities.

Rising temperatures along with decreases in snowfall and runoff likely would contribute to lower water storage volumes and elevations in Lake Powell, which in turn could adversely affect tourism and recreation in Page, Grand Canyon National Park, Navajo National Monument and other attractions. Potential climate change effects at those locations could include effects on plant and animal species and operations, which are indirectly linked to visitation and the local economic activity supported thereby. Similarly, climate change could affect outdoor recreation on the National Forests. Changes in precipitation patterns and rising temperatures would increase risk of wildland fires, which could further affect recreation and tourism in the region.

As noted in Section 3.2.4.1, many Navajo and Hopi rely on grazing, small-scale farming, and plant gathering, for subsistence, maintenance of cultural traditions, and in some cases, for supplementing their income. Grazing and small scale farming are both reliant on precipitation, springs, and seeps. Given current scarcity of water, even relatively modest changes in water availability could be detrimental for those activities on a localized level. Overpeck et al. (2013) concluded with high confidence that "Effects of climate change on the lands and people of Southwestern Native nations are likely to be greater than elsewhere because of endangered cultural practices, limited water rights, and social, economic, and political marginalization, all of which are relatively common among indigenous people." Such effects could extend to certain indigenous plants and animals that are culturally important for Navajo and necessary for their traditional religious practices.

Population on the Navajo Nation and Hopi Reservation likely would grow during the period from 2020 to 2044. However, the effects on agriculture and grazing defined above could result in increased off-reservation emigration of Navajo and Hopi for economic and quality-of-life purposes.

Although many Tribes, local and state governments, and water entities are developing strategies for adapting to a changing climate (Pincetl 2013; Redsteer et al. 2013; Udall 2013), the availability of resources to implement these strategies and their subsequent effectiveness are uncertain.

Strong population growth is forecast to continue in the coming decades (Section 3.18.3.3). The Arizona Department of Administration medium series forecasts for 2050 call for an 81 percent increase in population in Maricopa County, a 55 percent increase in population in Pima County, and a 229 percent increase in Pinal County. Under those forecasts the three county region would gain an additional 4.5 million residents by 2050.

Warming temperatures, potential changes in precipitation patterns, and the resultant effects on the physical and biological environment described in the preceding sections could have similar effects on the reservations, water utility, and agricultural interests in Maricopa, Pinal, and Pima counties to those described for the study area. Additionally, forecast reductions in Colorado River flows as well as the CAP system and its water delivery, would occur as described in Section 3.2.3.

Priority allocations for municipal and industrial, reservations, and non-reservation priority customers would not be affected. It is not known whether the climate change effects forecasted for the assessment period would result in reduced deliveries of excess water to the Arizona Water Banking Authority, groundwater replenishment programs, and the agricultural settlement pool. Fixed operations and maintenance costs would have to be absorbed by lower delivery volumes, requiring rate increases. Pumping energy requirements for CAP and associated energy and transmission costs would decline, potentially increasing the availability of excess energy for sale as surplus.

According to the CAWCD (2015), the agency and the Arizona Department of Water Resources are taking proactive steps to protect against the impacts of Colorado River water shortage, including storing water underground water storage, aquifer recharge programs, water efficiencies, desalinization programs, cloud seeding, and Lake Mead water storage programs.

Extended shortages of Colorado River water also would affect the overall pricing and demand for water in central and southern Arizona. A possible scenario would be higher interest in converting water from agricultural use to municipal and industrial use, with that interest expressed through higher offer prices for water. Whether this would occur, what future price levels might be, and what parties might be involved are all unknown.

Reductions in CAP water provided to agricultural users could result in lower agricultural production and reduced profitability of farms that rely on CAP water. However, "In the face of potential shortage, farmers in central Arizona may choose to offset supply reductions in their CAP supply by using local supplies including pumping groundwater" (CAWCD 2015).

Climate changes on socioeconomic conditions in the study area and in central and southern Arizona under either the 3-Unit Operation or 2-Unit Operation would be minor. Future emissions from NGS and the proposed KMC would be a very small increment within the context of future global emissions and likely would be too small to materially affect climatic influences in the region. NGS contributes approximately 2 percent of coal-fired generation nationally.

3.2.4.3.3 Social Cost of Carbon

Table 3.2-6 displays the estimated cumulative SCC for NGS under the Proposed Action over the 2020 to 2044 period based on the current IWG values and 3 percent and 5 percent discount rates.

Table 3.2-6 Social Cost of Carbon for the Proposed Action

NGS Operation	Annual CO_2 Emissions (metric tons)	SCC Present Value for 2020 to 2044 (2015 USD)		
		At 3% Discount ($ millions)	At 5% Discount ($ millions)	95th Percentile At 3% Discount ($ millions)
3-Unit Operation	18,240,000	$28,453	$9,121	$87,042
2-Unit Operation	12,203,000	$19,036	$6,099	$58,230

Based on the IWG on SCC values per metric ton at a 3 percent discount rate and adjusted to 2015 dollars, the Proposed Action 3-Unit Operation NGS emissions would generate an estimated SCC of $28,453 million over the period from 2020 to 2044 period. The corresponding estimates of aggregate SCC at a 5 percent rate would be $9,121 million, and the 95th/3 percent would be $87,042 million.

The estimated SCC for the Proposed Action 2-Unit Operation would be $19,036 million from 2020 to 2044 for the 3 percent discount rate and 2015 USD. Using a 5 percent discount rate, the aggregate SCC from 2020 to 2044 would be an estimated $6,099 million, with aggregate SCC of $58,230 million for the 95th/3 percent. The SCC for the Proposed Action 2-Unit Operation would be 33 percent lower than those for the Proposed Action 3-Unit Operation, which reflects the effects of shutting down one generating unit at NGS.

Because the PFR alternatives would affect only the federal share of NGS production, and thereby also account for the changes in coal production from the proposed KMC, the SCC estimates for the NGS Proposed Action were adjusted to reflect the federal share of emissions. The resulting values, using the SCC present value discounted at 3 percent would be $6,914 million for the Proposed Action 3-Unit Operation and $6,852 million for the Proposed Action 2-Unit Operation (**Table 3.2-7**). Although the numerical values derived for the federal share of emissions using the 2.5 percent and the 95th percentile at 3 percent SCC values from **Table 3.2-6** would differ from those shown, the numerical relationship would be consistent.

Table 3.2-7 Social Cost of Carbon for the Federal Share of NGS

NGS Operation	Federal Share of Annual CO_2 Emissions (metric tons)	SCC Present Value for 2020 to 2044 (millions of 2015 USD)
3-Unit Operation	4,432,300	$6,914
2-Unit Operation	4,393,100	$6,853

3.2.4.4 Natural Gas Partial Federal Replacement Alternative

3.2.4.4.1 Emissions

3.2.4.4.1.1 Navajo Generating Station

Under the Natural Gas Partial Federal Replacement (PFR) Alternative, a selected quantity of power between 100 megawatts (MW) and 250 MW would be contracted for under a long-term power purchase agreement from currently unidentified, existing natural gas generation sources, displacing an equivalent amount of power from the federal share of NGS generation. GHG emissions from the replacement power were based on a recent permit for the Bowie Power Plant in Arizona (Arizona Department of Environmental Quality 2014), which provided an estimate of 995 pounds of CO_2 per MW-hour for a 1,000-MW combined cycle plant. Replacement power would be drawn from this type of unit; therefore, the GHG associated with the generation of that power has been included in the total GHG emissions for this alternative. **Table 3.2-8** provides a tabular summary of GHG emissions. Data are provided for emissions of CO_2e and CO_2 in metric tons. Detailed calculations are provided in **Appendix 3.2-D**. The CO_2 emission data were used in the evaluation of the SCC. Natural Gas PFR Alternative does not include power generation from renewable sources.

Table 3.2-8 GHG Emissions Associated with the Natural Gas PFR Alternative

Parameter	3-Unit Operation		2-Unit Operation	
	100-MW Replacement	250-MW Replacement	100-MW Replacement	250-MW Replacement
Annual CO_2e Emissions (metric tons)				
NGS Generation	17,335,000	15,952,000	11,249,000	9,866,000
Replacement Generation	395,000	988,000	395,000	988,000
NGS Support Operations	130,000	130,000	130,000	130,000
Total Rounded	17,860,000	17,070,000	11,774,000	10,984,000
Annual CO_2 Emissions (metric tons)				
NGS Generation	17,196,000	15,824,000	11,159,000	9,787,000
Replacement Generation	395,000	987,000	395,000	987,000
NGS Support Operations	129,000	129,000	129,000	129,000
Total Rounded	17,720,000	16,940,000	11,683,000	10,903,000

3.2.4.4.1.2 Proposed Kayenta Mine Complex

Under the Natural Gas PFR Alternative, the proposed KMC would produce the coal to meet the expected power generation at NGS. For purposes of the analysis of GHG emissions, the changes in coal production were used to estimate the changes in GHG emissions both from methane emissions from coal mine operations and from GHG emissions from equipment operations. **Table 3.2-9** provides total emission rates for the Natural Gas PFR Alternative from the proposed KMC operations based on the total production of coal.

Table 3.2-9 GHG Emissions from Proposed KMC for the Natural Gas PFR Alternative

Operation	Proposed KMC Total Coal Production (million tpy)	Emissions (metric tpy in CO_2e)		
		Methane	Equipment	Total [1]
3-Unit Operation	8.1	15,600	55,300	71,000
3-Unit with 100-MW Replacement	7.7	14,900	53,400	68,000
3-Unit with 250-MW Replacement	7.1	13,800	50,500	64,000
2-Unit Operation	5.5	10,600	43,000	54,000
2-Unit with 100-MW Replacement	5.1	9,900	41,000	51,000
2-Unit with 250-MW Replacement	4.5	8,700	28,100	47,000

[1] Data rounded to 1,000.

3.2.4.4.1.3 Transmission Systems and Communication Sites

Except for the GHG emissions from maintenance operations and incidences of on-site emergency power generation (less than 10 metric tons annually), there would be no other GHG emissions associated with the transmission lines and communication sites (**Appendix 3.2-C**, Exhibit 3). The transmission system and communication sites would have no effect on GHG emissions because there would be a very small amount generated during future operation and maintenance. The effects of natural variability in climate conditions would be greater than any projected change in climate conditions related to these operations.

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

No new construction is proposed for the transmission lines and activities along the lines would be limited to routine and periodic major maintenance. Consequently, future climate change effects on these facilities and activities likely would be limited to the increased potential for damage associated with extreme weather events and wildfires, which could require additional maintenance or reconstruction of transmission lines and communication sites. The impacts of such events likely would be localized, short-term, and unpredictable in occurrence and intensity.

3.2.4.4.1.4 Project Impact Summary – All Project Components

The combined GHG emissions from the Natural Gas PFR Alternative are provided in **Table 3.2-10**. The data show the total emissions from both NGS and proposed KMC as well as a comparison to the total global CO_2e emissions projected for 2040. The extraction, transportation, and storage of natural gas also would be sources of methane emissions contributing to total CO_2e emissions. A separate calculation of emissions associated with these sources of emissions for providing natural gas to a combined cycle power plant are provided in **Appendix 3.2-D**, The calculations show approximately 10,000 metric tonnes of CO_2e per 100 MW of power generation for 1 year. Those GHG emissions would be negligible in comparison to the total GHG generated by the Proposed Action.

Table 3.2-10 Total Project Contribution to Global GHG for the Natural Gas PFR Alternative

Operation	Emissions (tpy in CO_2e)			Fraction of Global CO_2e in 2040
	NGS	Proposed KMC	Total Natural Gas PFR[1]	
3-Unit Operation	18,387,000	71,000	18,458,000	0.00026
3-Unit with 100-MW Replacement	17,860,000	68,000	17,928,000	0.00026
3-Unit with 250-MW Replacement	17,070,000	64,000	17,134,000	0.00025
2-Unit Operation	12,301,000	54,000	12,355,000	0.00018
2-Unit with 100-MW Replacement	11,774,000	51,000	11,825,000	0.00018
3-Unit with 100-MW Replacement	10,984,000	47,000	11,031,000	0.00016

[1] Data rounded to 1,000.

3.2.4.4.1.5 Cumulative Impacts

Local cumulative impacts related to climate change cannot be directly assessed because impacts of GHG emissions are a global issue only. There may be localized cumulative effects on climate, but any conjecture would be purely speculative. The cumulative impacts from the various operations under the Natural Gas PFR Alternative were compared to the global total cumulative emission estimates during the proposed period of the Alternative operation. **Table 3.2-11** provides a comparison of the total GHG emissions as a fraction of that total, for the period 2020 through 2044 as well as out to 2050. Global CO2e emissions would increase by 52 percent from 2020 to 2050, a major impact (**Table 3.2-11**).

Table 3.2-11 Total Natural Gas PFR Alternative Contribution to Global GHG

Operation	Fraction of GHG Emissions from PFR Alternative to Global Total			
	2020	2030	2040	2050
3-Unit Operation				
3-Unit with 100-MW Replacement	0.00035	0.00029	0.00026	0.00022
3-Unit with 250-MW Replacement	0.00033	0.00028	0.00025	0.00021
2-Unit Operation				
2-Unit with 100-MW Replacement	0.00023	0.00019	0.00017	0.00015
3-Unit with 100-MW Replacement	0.00021	0.00018	0.00016	0.00014
Global Total CO_2e Emissions (giga-tonne)	52	61	70	80

Global Total CO_2e Emissions giga-tonne = 109 metric tonnes = 1,015 g.

3.2.4.4.2 Socioeconomics

Climate change effects on socioeconomic conditions in the study area and in central and southern Arizona under the any configuration of the Natural Gas PFR Alternative would be minor and the same as Proposed Action.

3.2.4.4.3 Social Cost of Carbon

Table 3.2-12 displays the estimated NGS SCC over the period from 2020 to 2044 based on the current IWG values (**Table 3.2-2**) for the Natural Gas PFR Alternative at 3 percent and 5 percent discount rates, as well as for the 95th percentile at 3 percent. The differences in SCC for the Natural Gas PFR Alternative compared to the corresponding Proposed Action operation also are presented.

Table 3.2-12 Social Cost of Carbon for the Natural Gas PFR Alternatives

NGS Operation	Annual CO_2 Emissions (metric tons)	SCC Present Value for 2020 to 2044 (2015 USD)			Difference Compared to the Proposed Action
		At 3% Discount ($ millions)	At 5% Discount ($ millions)	95th Percentile At 3% ($ millions)	
3-Unit Operation	18,240,000	$28,453	$9,121	$87,042	NA
3-Unit with 100-MW Replacement	17,720,000	$27,643	$8,861	$84,569	-3%
3-Unit with 250-MW Replacement	16,940,000	$26,429	$8,473	$80,837	-7%
2-Unit Operation	12,203,000	$19,036	$6,099	$58,230	NA
2-Unit with 100-MW Replacement	11,683,000	$18,225	$5,842	$55,751	-4%
2-Unit with 250-MW Replacement	10,903,000	$17,010	$5,454	$52,029	-11%

The estimated SCC for the Natural Gas PFR Alternative at a 3 percent discount rate would be between $17,010 million and $27,643 million over the period from 2020 to 2044 (**Table 3.2-12**). At the 5 percent discount rate, the aggregate SCC would range between $5,454 million and $8,861 million, with aggregate SCC or the 95th percentile at a 3 percent discount rate between $52,029 million and $82,569 million. This would be 3 to 11 percent lower than the corresponding values associated with the Proposed Action.

Applying the differences in SCC achieved under the Natural Gas PFR Alternative to the federal share of total emissions would increase the relative changes in SCC achieved. As shown in **Table 3.2-13**, the present value of the SCC associated with those emissions would correspond to between 12 and 29 percent reduction in conjunction with the 3-Unit Operation and between 12 and 30 percent reduction in conjunction with the 2-Unit NGS Operation.

Table 3.2-13 Social Cost of Carbon for the Federal Share of NGS with Natural Gas PFR

NGS Operation	Federal Share of Annual CO_2 Emissions (metric tons)	SCC Present Value for 2020 to 2044 (millions of 2015 USD)		
		Federal Share at 3 Percent	Difference Compared to Proposed Action	Percent Difference
3-Unit Operation	4,432,300	$6,914	NA	NA
3-Unit with 100-MW Replacement	3,912,300	$6,103	$(811)	-12%
3-Unit with 250-MW Replacement	3,132,300	$4,886	$(2,028)	-29%
2-Unit Operation	4,393,100	$6,853	NA	NA
2-Unit with 100-MW Replacement	3,873,100	$6,042	($811)	-12%
2-Unit with 250-MW Replacement	3,093,100	$4,825	($2,028)	-30%

3.2.4.5 Renewable Partial Federal Replacement Alternative

3.2.4.5.1 Emissions

3.2.4.5.1.1 Navajo Generating Station

Under the Renewable PFR Alternative, a selected quantity of power between 100 MW and 250 MW would be contracted for under a long-term power purchase agreement from a currently unidentified, existing renewable energy power source, displacing an equivalent amount of power from the federal share of NGS generation. There would be no emissions associated with the renewable replacement operations; however, the Renewable PFR Alternative assumes that this installation would require firming power generation. See Section 2.2.3 for details regarding firming power. This alternative would require an additional supply of regulation,[3] which is assumed to be 6 percent of each of the renewable generation production levels annually.

The 100-MW to 250-MW replacement design can apply to either the 3-Unit Operation or 2-Unit Operation. GHG emissions from the firming power were based on the emissions that would be associated with a modern combined cycle natural gas fired power plant, with an identical GHG emission rate of 995 lbs. of CO_2 per MW-hour. Similar to the Natural Gas PFR Alternative, the range of emissions under this alternative extends from emissions associated with the 3-Unit Operation with 100-MW replacement power to emissions associated with the 2-Unit Operation with 250-MW replacement power. **Table 3.2-14** provides a tabular summary of GHG emissions from the range of operations. Data are provided for emissions of CO_2e and CO_2 in metric tons. Detailed calculations are provided in **Appendix 3.2-D**. The CO_2 emission data were used in the evaluation of the SCC.

Table 3.2-14 GHG Emissions Associated with the Renewable PFR Alternative

Parameter	3-Unit Operation		2-Unit Operation	
	100-MW Replacement	250-MW Replacement	100-MW Replacement	250-MW Replacement
Annual CO_2e Emissions (metric tons)				
NGS Generation	17,719,000	16,913,000	11,634,000	10,827,000
Firm Power Generation	14,000	35,000	14,000	35,000
NGS Support Operations	130,000	130,000	130,000	130,000
Total Rounded	17,863,000	17,078,000	11,778,000	10,992,000
Annual CO_2 Emissions (metric tons)				
NGS Generation	17,578,000	16,778,000	11,541,000	10,741,000
Firm Power Generation	14,000	35,000	14,000	35,000
NGS Support Operations	129,000	129,000	129,000	129,000
Total Rounded	17,721,000	16,942,000	11,684,000	10,905,000

3.2.4.5.1.2 Proposed Kayenta Mine Complex

Under the Renewable PFR Alternative, the proposed KMC would produce the coal to meet the expected power generation at NGS. For purposes of the analysis of GHG emissions, the changes in coal production were used to estimate the changes in GHG emissions both from methane emissions from coal mine operations and from GHG emissions from equipment operations. **Table 3.2-15** provides total

[3] Regulation refers to backup generating capacity and power that can be supplied very quickly from another source on an “as needed” basis. For this assessment such support is assumed to be supplied by a modern combined cycle natural gas fired power plant.

emission rates for the Natural Gas PFR Alternative from the proposed KMC operations based on the total production of coal.

Table 3.2-15 GHG Emissions from Proposed KMC for the Renewable PFR Alternative

Operation	Proposed KMC Total Coal Production (million tpy)	Emissions (metric tpy in CO_2e)		
		Methane	Equipment	Total [1]
3-Unit Operation	8.1	15,600	65,300	71,000
3-Unit with 100-MW Replacement	7.7	15,200	54,200	69,000
3-Unit with 250-MW Replacement	7.1	14,500	52,500	67,000
2-Unit Operation	5.5	10,600	43,000	54,000
2-Unit with 100-MW Replacement	5.1	10,200	41,900	52,000
2-Unit with 250-MW Replacement	4.5	9,500	40,100	50,000

[1] Data rounded to 1,000.

3.2.4.5.1.3 Transmission Systems and Communication Sites

Except for the GHG emissions from maintenance operations and incidences of on-site emergency power generation (less than 10 metric tons annually), there would be no other GHG emissions associated with the transmission lines and communication sites (**Appendix 3.2-C**, Exhibit 3). The transmission system and communication sites would have no effect on GHG emissions because there would be a very small amount generated during future operation and maintenance. The effects of natural variability in climate conditions would be greater than any projected change in climate conditions related to these operations.

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

No new construction is proposed for the transmission lines and activities along the lines would be limited to routine and periodic major maintenance. Consequently, future climate change effects on these facilities and activities likely would be limited to the increased potential for damage associated with extreme weather events and wildfires, which could require additional maintenance or reconstruction of transmission lines and communication sites. The impacts of such events likely would be localized, short-term, and unpredictable in occurrence and intensity.

3.2.4.5.1.4 Project Impact Summary – All Project Components

The combined GHG emissions from the Renewable PFR Alternative are provided in **Table 3.2-16**. The data show the total emissions from both NGS and proposed KMC as well as a comparison to the total global CO_2e emissions projected for 2040.

Table 3.2-16 Total Project Contribution to Global GHG for Renewable PFR Alternative

Operation	Emissions (tpy in CO_2e)			Fraction of Global CO_2e in 2040
	NGS	Proposed KMC	Total Renewable PFR[1]	
3-Unit Operation	18,387,000	71,000	18,458,000	0.00026
3-Unit with 100-MW Replacement	17,868,000	69,000	17,932,000	0.00026
3-Unit with 250-MW Replacement	17,078,000	67,000	17,145,000	0.00025
2-Unit Operation	12,301,000	54,000	12,355,000	0.00018
2-Unit with 100-MW Replacement	11,778,000	52,000	11,830,000	0.00017
3-Unit with 250-MW Replacement	10,992,000	50,000	11,042,000	0.00016

[1] Data rounded to 1,000.

3.2.4.5.1.5 Cumulative Impacts

Cumulative impacts related to climate change cannot be directly assessed because impacts of GHG emissions are a global issue only. There may be localized cumulative effects on climate, but any conjecture would be purely speculative. The cumulative impacts from the various operations under the Renewable PFR Alternative were compared to the global total cumulative emission estimates during the proposed period of operation. **Table 3.2-17** provides a comparison of the total GHG emissions as a fraction of that total, for the period 2020 through 2044 as well as out to 2050. Global CO_2e emissions would increase by 52 percent from 2020 to 2050, a major impact (**Table 3.2-17**).

Table 3.2-17 Total Renewable PFR Alternative Contribution to Global GHG Emissions

Operation	Fraction of GHG Emissions from PFR Alternative to Global Total			
	2020	2030	2040	2050
3-Unit Operation				
3-Unit with 100-MW Replacement	0.00035	0.00029	0.00026	0.00022
3-Unit with 250-MW Replacement	0.00033	0.00028	0.00025	0.00021
2-Unit Operation				
2-Unit with 100-MW Replacement	0.00023	0.00019	0.00017	0.00015
3-Unit with 100-MW Replacement	0.00021	0.00018	0.00016	0.00014
Global Total CO_2e Emissions (giga-tonne)	52	61	70	80

giga-tonne = 109 metric tonnes = 1,015 g.

3.2.4.5.2 Socioeconomics

Climate change effects on socioeconomic conditions in the study area and in central and southern Arizona under the any configuration of the Renewable PFR Alternative would be minor and the same as the Proposed Action.

3.2.4.5.3 Social Cost of Carbon

Table 3.2-18 displays the estimated NGS SCC over the period from 2020 to 2044 based on the current IWG values (**Table 3.2-2**) for the Renewable PFR Alternative at 3 percent and 5 percent discount rates, as well as for the 95th percentile at 3 percent. The differences in SCC for the Renewable PFR Alternative compared to the corresponding Proposed Action operations also are presented.

The estimated NGS SCC for the Renewable PFR Alternative at a 3 percent discount rate would be between $17,011 million and $27,643 million over the period from 2020 to 2044 (**Table 3.2-18**). At the 5 percent discount rate, the aggregate SCC would range between $5,454 million and $8,861 million, with aggregate SCC for the 95th percentile at a 3 percent discount rate between $52,040 million and $84,569 million. This would be 3 to 11 percent lower than those associated with the Proposed Action.

Table 3.2-18 Social Cost of Carbon for the Renewable PFR Alternative

NGS Operation	Annual CO_2 Emissions (metric tons)	SCC Present Value for 2020 to 2044 (2015 USD)			Difference Compared to the Proposed Action
		At 3% Discount ($ millions)	At 5% Discount ($ millions)	95th Percentile At 3% Discount ($ millions)	
3-Unit Operation	18,240,000	$28,453	$9,121	$87,042	NA
3-Unit with 100-MW Replacement	17,721,000	$27,643	$8,861	$84,569	-3%
3-Unit with 250-MW Replacement	16,942,000	$26,431	$8,473	$80,848	-7%
2-Unit Operation	12,203,000	$19,036	$6,099	$58,230	NA
2-Unit with 100-MW Replacement	11,684,000	$18,228	$5,842	$55,755	-4%
2-Unit with 250-MW Replacement	10,905,000	$17,011	$5,454	$52,040	-11%

Applying the differences in SCC achieved under the Renewable PFR Alternative to the federal share of NGS emissions would increase the relative changes in SCC achieved. As shown in **Table 3.2-19**, the present value of the SCC associated with those emissions correspond to between 12 and 29 percent reduction in conjunction with the 3-Unit Operation and between 12 and 30 percent reduction in conjunction with the 2-Unit Operation.

Table 3.2-19 Social Cost of Carbon for the Federal Share of NGS with Renewable PFR

NGS Operation	Federal Share of Annual CO_2 Emissions (metric tons)	SCC Present Value for 2020 – 2044 (2015 USD)		
		Federal Share at 3 Percent	Difference Compared to Proposed Action	Percent Difference
3-Unit Operation	4,432,300	$6,914	NA	
3-Unit with 100-MW Replacement	3,913,300	$6,104	$(810)	-12%
3-Unit with 250-MW Replacement	3,134,300	$4,889	$(2,025)	-29%
2-Unit Operation	4,393,100	$6,853	NA	NA
2-Unit with 100-MW Replacement	3,874,100	$6,043	$(810)	-12%
2-Unit with 250-MW Replacement	3,095,100	$4,828	$(2,025)	-30%

3.2.4.6 Tribal Partial Federal Replacement Alternative

3.2.4.6.1 Emissions

3.2.4.6.1.1 Navajo Generating Station

Under the Tribal PFR Alternative, between 100 MW and 250 MW of power generation from the NGS would be replaced by power supplied by a new photovoltaic generation facility on tribal land, displacing an equivalent amount of power from the federal share of NGS generation. The Tribal PFR facility would be analyzed in a separate NEPA process once a facility location is identified. Similar to the analysis for the Renewable PFR Alternative, the Tribal PFR Alternative assumes that this installation would require firming power generation. See Section 2.2.3 for details regarding firming power. This alternative also would require regulation, which is assumed to be 6 percent of the renewable generation production levels annually.

The 100-MW to 250-MW peak delivery designs can apply to either the 3-Unit Operation or 2-Unit Operation. GHG emissions from the firming power based on the emissions that would be associated with a modern combined cycle natural gas fired power plant, with a GHG emission rate of 995 pounds of CO_2 per MW-hour. Similar to the Natural Gas and Renewable PFR alternatives, the range of emissions under this alternative extends from emissions associated with the 3-Unit Operation with 100-MW replacement power to emissions associated with the 2-Unit Operation with 250-MW replacement power. **Table 3.2-20** provides a tabular summary of GHG emissions from the range of operations. Data are provided for emissions of CO_2e and CO_2 in metric tons. Detailed calculations are provided in **Appendix 3.2-D**. The CO_2 emission data were used in the evaluation of the SCC.

Table 3.2-20 GHG Emissions Associated with the Tribal PFR Alternative

Parameter	3-Unit Operation		2-Unit Operation	
	100-MW Replacement	250-MW Replacement	100-MW Replacement	250-MW Replacement
Annual CO_2e Emissions (metric tons)				
NGS Generation	17,907,000	17,381,000	11,821,000	11,296,000
Firm Power Generation	9,000	23,000	9,000	23,000
NGS Support Operations	130,000	130,000	130,000	130,000
Total Rounded	18,046,000	17,534,000	11,960,000	11,449,000
Annual CO_2 Emissions (metric tons)				
NGS Generation	17,763,000	17,242,000	11,726,000	11,206,000
Firm Power Generation	9,000	23,000	9,000	23,000
NGS Support Operations	129,000	129,000	129,000	129,000
Total Rounded	17,901,000	17,394,000	11,864,000	11,358,000

3.2.4.6.1.2 Proposed Kayenta Mine Complex

Under the Tribal PFR Alternative, the proposed KMC would produce the coal to meet the expected power generation at NGS. For purposes of the analysis of GHG emissions, the changes in coal production were used to estimate the changes in GHG emissions both from methane emissions from coal mine operations and from GHG emissions from equipment operations. **Table 3.2-21** provides total emission rates for the Natural Gas PFR Alternative from the proposed KMC operations based on the total production of coal.

Table 3.2-21 GHG Emissions from Proposed KMC for the Tribal PFR Alternative

Operation	Proposed KMC Total Coal Production (million tpy)	Emissions (metric tpy in CO_2e)		
		Methane	Equipment	Total [1]
3-Unit Operation	8.1	15,600	55,300	71,000
3-Unit with 100-MW Replacement	7.7	15,300	54,600	70,000
3-Unit with 250-MW Replacement	7.1	14,800	53,500	68,000
2-Unit Operation	5.5	10,600	43,000	54,000
2-Unit with 100-MW Replacement	5.1	10,300	42,300	53,000
2-Unit with 250-MW Replacement	4.5	9,800	41,100	51,000

[1] Data rounded to 1,000.

3.2.4.6.1.3 Transmission Systems and Communication Sites

Except for the GHG emissions from maintenance operations and incidences of on-site emergency power generation (less than 10 metric tons annually), there would be no other GHG emissions associated with the transmission lines and communication sites (**Appendix 3.2-C**, Exhibit 3). The transmission system and communication sites would have no effect on GHG emissions because there would be a very small amount generated during future operation and maintenance. The effects of natural variability in climate conditions would be greater than any projected change in climate conditions related to these operations.

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

No new construction is proposed for the transmission lines and activities along the lines would be limited to routine and periodic major maintenance. Consequently, future climate change effects on these facilities and activities likely would be limited to the increased potential for damage associated with extreme weather events and wildfires, which could require additional maintenance or reconstruction of transmission lines and communication sites. The impacts of such events likely would be localized, short-term, and unpredictable in occurrence and intensity.

3.2.4.6.1.4 Project Impact Summary – All Project Components

The combined GHG emissions from the Tribal PFR Alternative are provided in **Table 3.2-22**. The data show the total emissions from both NGS and proposed KMC as well as a comparison to the total global CO_2e emissions projected for 2040.

Table 3.2-22 Total Project Contribution to Global GHG for Tribal PFR Alternative

Operation	Emissions (tpy in CO_2e)			Fraction of Global CO_2e in 2040
	NGS	Proposed KMC	Total Tribal PFR[1]	
3-Unit Operation	18,387,000	71,000	18,458,000	0.00026
3-Unit with 100-MW Replacement	18,046,000	70,000	18,116,000	0.00026
3-Unit with 250-MW Replacement	17,534,000	68,000	17,602,000	0.00025

Table 3.2-22 Total Project Contribution to Global GHG for Tribal PFR Alternative

Operation	Emissions (tpy in CO_2e)			Fraction of Global CO_2e in 2040
	NGS	Proposed KMC	Total Tribal PFR[1]	
2-Unit Operation	12,301,000	54,000	12,355,000	0.00018
2-Unit with 100-MW Replacement	11,960,000	53,000	12,013,000	0.00017
2-Unit with 250-MW Replacement	11,449,000	51,000	11,500,000	0.00016

[1] Data rounded to 1,000.

3.2.4.6.1.5 Cumulative Impacts

Cumulative impacts related to climate change cannot be directly assessed because impacts of GHG emissions are a global issue only. There may be localized cumulative effects on climate, but any conjecture would be purely speculative. The cumulative impacts from the various operations under the Tribal PFR Alternative were compared to the global total cumulative emission estimates during the proposed period of operation. **Table 3.2-23** provides a comparison of the total GHG emissions as a fraction of that total, for the period 2020 through 2044 as well as out to 2050. Global CO_2e emissions would increase by 52 percent from 2020 to 2050, a major impact (**Table 3.2-23**).

Table 3.2-23 Total Tribal PFR Alternative Contribution to Global GHG Emissions

Operation	Fraction of GHG Emissions from PFR Alternative to Global Total			
	2020	2030	2040	2050
3-Unit Operation				
3-Unit with 100-MW Replacement	0.00035	0.00030	0.00026	0.00023
3-Unit with 250-MW Replacement	0.00034	0.00029	0.00025	0.00022
2-Unit Operation				
2-Unit with 100-MW Replacement	0.00023	0.00020	0.00017	0.00015
2-Unit with 250-MW Replacement	0.00022	0.00019	0.00016	0.00014
Global Total CO_2e Emissions	52	61	70	80

giga-tonne = 109 metric tonnes = 1,015 g.

3.2.4.6.2 Socioeconomics

Climate change impacts on socioeconomic conditions in the study area and in central and southern Arizona under any configuration of the Tribal PFR Alternative would be minor and the same as the Proposed Action.

3.2.4.6.3 Social Cost of Carbon

Table 3.2-24 displays the estimated SCC over the period from2020 to 2044 based on the current IWG values (**Table 3.2-2**) for the Tribal PFR Alternatives at 3 percent and 5 percent discount rates, as well as for the 95th percentile at 3 percent. The differences in SCC for the Tribal PFR Alternative compared to the corresponding Proposed Action operations also are presented.

The estimated SCC for the Tribal PFR alternatives, at a 3 percent discount rate would be between \$17,719 million and \$27,926 million over the period from 2020 to 2044 (**Table 3.2-24**). At the 5 percent discount rate, the aggregate SCC would range between \$5,678 million and \$8,952 million, with aggregate SCC for the 95th percentile at a 3 percent discount rate between $54,199 million and $85,423 million. This would be 2 to 7 percent lower than those associated with the Proposed Action.

Table 3.2-24 Social Cost of Carbon for the Tribal PFR Alternative

Operation	Annual CO_2 Emissions (metric tons)	SCC Present Value for 2020 to 2044 (2015 USD) At 3% Discount ($ millions)	At 5% Discount ($ millions)	At 3% Discount & 95th Percentile ($ millions)	Difference Compared to the Proposed Action
3-Unit Operation	18,240,000	$28,453	$9,121	$87,042	NA
3-Unit with 100-MW Replacement	17,901,000	$27,926	$8,952	$85,423	-2%
3-Unit with 250-MW Replacement	17,394,000	$27,134	$8,697	$83,004	-5%
2-Unit Operation	12,203,000	$19,036	$6,099	$58,230	NA
2-Unit with 100-MW Replacement	11,864,000	$18,508	$5,934	$56,616	-3%
2-Unit with 250-MW Replacement	11,358,000	$17,719	$5,678	$54,199	-7%

Applying the differences in SCC achieved under the Tribal PFR Alternative to the federal share of total emissions would increase the relative changes in SCC achieved. As shown in **Table 3.2-25**, the present value of the SCC associated with those emissions would correspond to between 8 and 19 percent reduction in conjunction with the 3-Unit Operation and between 9 and 19 percent reduction in conjunction with the 2-Unit Operation.

Table 3.2-25 Social Cost of Carbon for the Federal Share of NGS with Tribal PFR

Operation	Federal Share of Annual CO_2 Emissions (metric tons)	SCC Present Value for 2020 to 2044 (millions of 2015 USD) Federal Share at 3 Percent ($ Millions)	Difference Compared to Proposed Action	Percent Difference
3-Unit Operation	4,432,300	$6,914	NA	
3-Unit with 100-MW Replacement	4,093,300	$6,385	$(529)	-8%
3-Unit with 250-MW Replacement	3,586,300	$5,594	$(1,320)	-19%
2-Unit Operation	4,393,100	$6,853	NA	NA
2-Unit with 100-MW Replacement	4,254,100	$6,324	($529)	-9%
2-Unit with 250-MW Replacement	3,548,100	$5,444	($1,318)	-19%

3.2.4.7 No Action

3.2.4.7.1 Emissions

Under the No Action Alternative power product ion at NGS would cease and all associated emissions and impacts from future operations would not occur. Immediately following cessation of operations, there may be site closure and remediation activities that would generate emissions; however, any GHG emissions from such activity likely would be negligible.

For purposes of determining the SCC, the No Action assumed that the NGS Participants would secure power from combined cycle natural gas generation sources. The generation of power by a modern combined cycle natural gas fired power plant could be estimated based on the data for the Bowie Power Plant cited above; however, for such an operation, additional GHG emissions would be attributed to a base load unit, including startup and shutdown emissions. If replaced by a modern combined cycle natural gas fired power plant, an estimated 8.63 million metric tons/year of CO_2 would be emitted by that replacement operation (**Appendix 3.2-E**).

Under the No Action Alternative, all coal production at proposed KMC would cease; and other than remedial activity and efforts associated with decommissioning or shutdown, there would be no GHG emissions from the proposed KMC. Temporary emissions would be associated with reclamation activities until the site has achieved final bond release. Reclamation activities are defined in the approved reclamation plan. Activities would be similar to the overburden handling activities in place for normal operations at the mine. Emissions would be associated with heavy equipment operation engine exhaust, and fugitive dust emissions associated with wind erosion and overburden replacement, including soil transfers, bulldozing, grading, and topsoil replacement. Impacts would be similar to operations under the Proposed Action.

The NGS transmission system is an established part of the western U.S. transmission grid and supports reliability and delivery of power throughout the region, well beyond the power generated by the NGS. Therefore, under the No Action Alternative it is likely that that one, several, or all of the land owners/managers of the transmission line rights-of-way and communication site leases would renew some portion of the facilities to keep the power grid performing as expected.

In the event it is determined that some or all of the transmission systems and communication site ROWs are not renewed, a lengthy study and permitting process would need to occur before any decommissioning is initiated due to the essential and integral nature of these facilities with the western electric grid. As noted in Section 2.3.3, up to 4,826 acres within and alongside the transmission system corridors could be temporarily disturbed if the entirety of the transmission systems and communication sites were decommissioned and removed.

3.2.4.7.2 Socioeconomics

Climate changes effects on socioeconomic conditions in the study area and in central and southern Arizona under the No Action would not differ appreciably from those associated with the Proposed Action. This conclusion reflects the fact that although the No Action would result in lower future emission levels than the Proposed Action, the differences in emissions would represent a very small increment within the context of future global emissions and likely would be too small to materially affect climatic influences in the region.

3.2.4.7.3 Social Cost of Carbon

For purposes of the SCC analysis, No Action assumed that NGS would shut down, and that the NGS participants move to secure power from combined cycle natural gas generation sources. Under this scenario, the CAP would procure only the power needed to operate its system and the closure of NGS would eliminate the opportunity for Reclamation to generate and market surplus power under its current authority.

As described in Section 2.4.1, under the No Action Alternative, the required federal approvals to extend the operations of NGS beyond December 2019 would not be obtained. Decommissioning activities would begin in 2018 with effective shutdown of the plant occurring by the end of 2019. While some minor emissions associated with equipment needed for decommissioning would extend beyond 2019, NGS emissions and the associated SCC would cease at the completion of decommissioning activities. As noted above, this analysis assumes that the NGS Participants would secure replacement power from other, presumably non-coal fired, and likely natural gas fired sources. Carbon emissions for combined cycle natural gas sources are substantially lower than those from coal-fired generation. As a result, annual emissions from such sources are estimated at 8.63 million metric tpy, approximately 47 percent of the emission for the Proposed Action 3-Unit Operation. The corresponding SCC estimates associated with those emissions from 2020 to 2044 (all expressed in 2015 dollars) would be $13,462 million at a 3 percent discount rate, $4,313 million at a 5 percent discount rate, and $41,183 million for the 95th percentile at a 3 percent discount rate (**Table 3.2-26**).

Table 3.2-26 Estimated Social Cost of Carbon for No Action Alternative

NGS Configuration	Annual CO_2 Emissions (metric tons)	SCC Present Value for 2020 to 2044 (2015 USD)		
		At 3% Discount ($ millions)	At 5% Discount ($ millions)	95th Percentile at 3% Discount ($ millions)
3-Unit Operation	18,240,000	$28,453	$9,121	$87,042
2-Unit Operation	12,203,000	$19,036	$6,099	$58,230
No Action [1]	8,630,000	$13,462	$4,313	$41,183

[1] For purposes of comparison, No Action emissions assuming natural gas generation reflect the replacement of the total NGS output and the federal share of output (i.e.,2,250 MW and 547 MW, respectively). However, replacement of the federal share under No Action likely would involve only approximately 300 MW to 350 MW to meet CAP's load requirement.

The annual CO_2 emissions and associated SCC values shown in **Table 3.2-26** would be for the overall project. As part of the SCC assessment for the Proposed Action and action alternatives, those totals are factored by 24.3 percent to focus on the effects of prospective changes in the federal share of emissions from NGS. Such a comparison would not be directly pertinent under No Action because operations of NGS would cease and Central Arizona Water Conservation District would need to secure an alternative source of electrical energy. In other words, there would no longer be a federal share of emissions. However, emissions would likely be associated with energy obtained from another source. Due to the reliability requirements associated with Central Arizona Water Conservation District's energy needs, natural gas generation was assumed for this analysis. Under that assumption, future emissions for the No Action Alternative associated with a comparable quantity of energy as would be derived for the federal share of the Proposed Action operations would reduce emissions and associated SCC over the period from 2020 to 2045 by approximately 53 percent (**Table 3.2-27**).

Table 3.2-27 Estimated Social Cost of Carbon for No Action Alternative Compared to Proposed Action Operations

NGS Configuration	Federal Share of Annual CO_2 Emissions (metric tons)	SCC Present Value for 2020 to 2044, (millions of 2015 USD)
		Federal Share at 3 Percent
3-Unit Operation	4,432,300	$6,914
2-Unit Operation	4,393,100	$6,853
No Action [1]	2,097,100	$3,271

[1] For purposes of comparison, No Action emissions assuming natural gas generation reflect the replacement of the total federal share of output (i.e., 547 MW. However, replacement of the federal share under No Action likely would involve only approximately 300 MW to 350 MW to meet CAP's load requirement.

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Section 3.3

Geology and Landforms

Acronyms and Abbreviations

1969 Lease	Navajo Project Indenture of Lease
BART	Best Available Retrofit Technology
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BM&LP Railroad	Black Mesa & Lake Powell Railroad
BO	Biological Opinion
CAP	Central Arizona Project
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CO_2	carbon dioxide
Co-tenants	Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
Development Fund	Lower Colorado River Basin Development Fund
EIS	Environmental Impact Statement
ERA	Ecological Risk Assessment
ESA	Endangered Species Act of 1973
HHRA	Human Health Risk Assessment
km	kilometer
KMC	Kayenta Mine Complex
kV	kilovolt
kW	kilowatt
MW	megawatt
N-Aquifer	Navajo Aquifer
NEPA	National Environmental Policy Act of 1969, as amended
NGS	Navajo Generating Station
NGS Participants	U.S. (Reclamation), Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
NHPA	National Historic Preservation Act
NNEPA	Navajo Nation Environmental Protection Agency
NO_2	nitrogen dioxide
NO_X	nitrogen oxide
OSMRE	Office of Surface Mining Reclamation and Enforcement
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 microns or less
PFR	Partial Federal Replacement
PWCC	Peabody Western Coal Company
Reclamation	Bureau of Reclamation
ROW	Right-of-way

SO_2	sulfur dioxide
SRP	Salt River Project Agricultural Improvement and Power District
STS	Southern Transportation System
tpy	tons per year
U.S.	United States
USEPA	U.S. Environmental Protection Agency
WTS	Western Transportation System

Contents

3.3 Geology and Landforms 3.3-1
3.3.1 Regulatory Framework 3.3-1
3.3.2 Study Areas 3.3-1
3.3.2.1 Proposed Action and Action Alternatives 3.3-1
3.3.2.2 Cumulative 3.3-1
3.3.3 Affected Environment 3.3-1
3.3.3.1 Navajo Generating Station 3.3-6
3.3.3.2 Proposed Kayenta Mine Complex 3.3-7
3.3.3.3 Transmission Systems and Communication Sites 3.3-8
3.3.4 Environmental Consequences 3.3-11
3.3.4.1 Issues 3.3-11
3.3.4.2 Assumptions and Impact Methodology 3.3-11
3.3.4.3 Proposed Action 3.3-12
3.3.4.4 Natural Gas Partial Federal Replacement Alternative 3.3-15
3.3.4.5 Renewable Partial Federal Replacement Alternative 3.3-18
3.3.4.6 Tribal Partial Federal Replacement Alternative 3.3-20
3.3.4.7 No Action 3.3-22
3.3.5 References 3.3-24

List of Tables

Table 3.3-1 Geologic Units at Communication Sites 3.3-10
Table 3.3-2 Overburden Disturbance: High and Low Production Comparison 3.3-13
Table 3.3-3 Proposed KMC Annual Coal Production and Annual Overburden Disturbance 3.3-16

List of Figures

Figure 3.3-1 Physiography and Project Components 3.3-2
Figure 3.3-2 Stratigraphic Chart 3.3-4
Figure 3.3-3 Surficial Geology 3.3-5
Figure 3.3-4 Quaternary Faults 3.3-9

3.3 Geology and Landforms

3.3.1 Regulatory Framework

Federal laws which protect unique geologic features include the National Environmental Policy Act (NEPA), National Forest Management Act of 1976, National Park Service Organic Act, National Wild and Scenic Rivers Act, and Federal Land Policy and Management Act.

The Arizona Geologic Survey is tasked under Arizona Revised Statutes to catalog and archive data on the location of earth fissures (Allison and Shipman 2007). Utah and Nevada do not have similar state laws regarding geologic hazards.

3.3.2 Study Areas

3.3.2.1 Proposed Action and Action Alternatives

The study area for geology and landforms includes the Navajo Generating Station (NGS) and associated facilities, and the proposed Kayenta Mine Complex (KMC). Associated facilities of the NGS include the Black Mesa & Lake Powell (BM&LP) Railroad right-of-way (ROW) that extends from the proposed KMC to the NGS (**Figure 3.3-1**). Associated facilities of the NGS also include the coal combustion residuals disposal site, lake pumping station, water pipeline, a 230-kilovolt (kV) electrical transmission line, powerlines from the pump station to the NGS, the road between Navajo Nation Route 22B and the pump station, and the coal loadout facility (**Table 1-2, Figure 1-3**). In addition, the study area extends along the maintained transmission system corridor ROWs and communication sites.

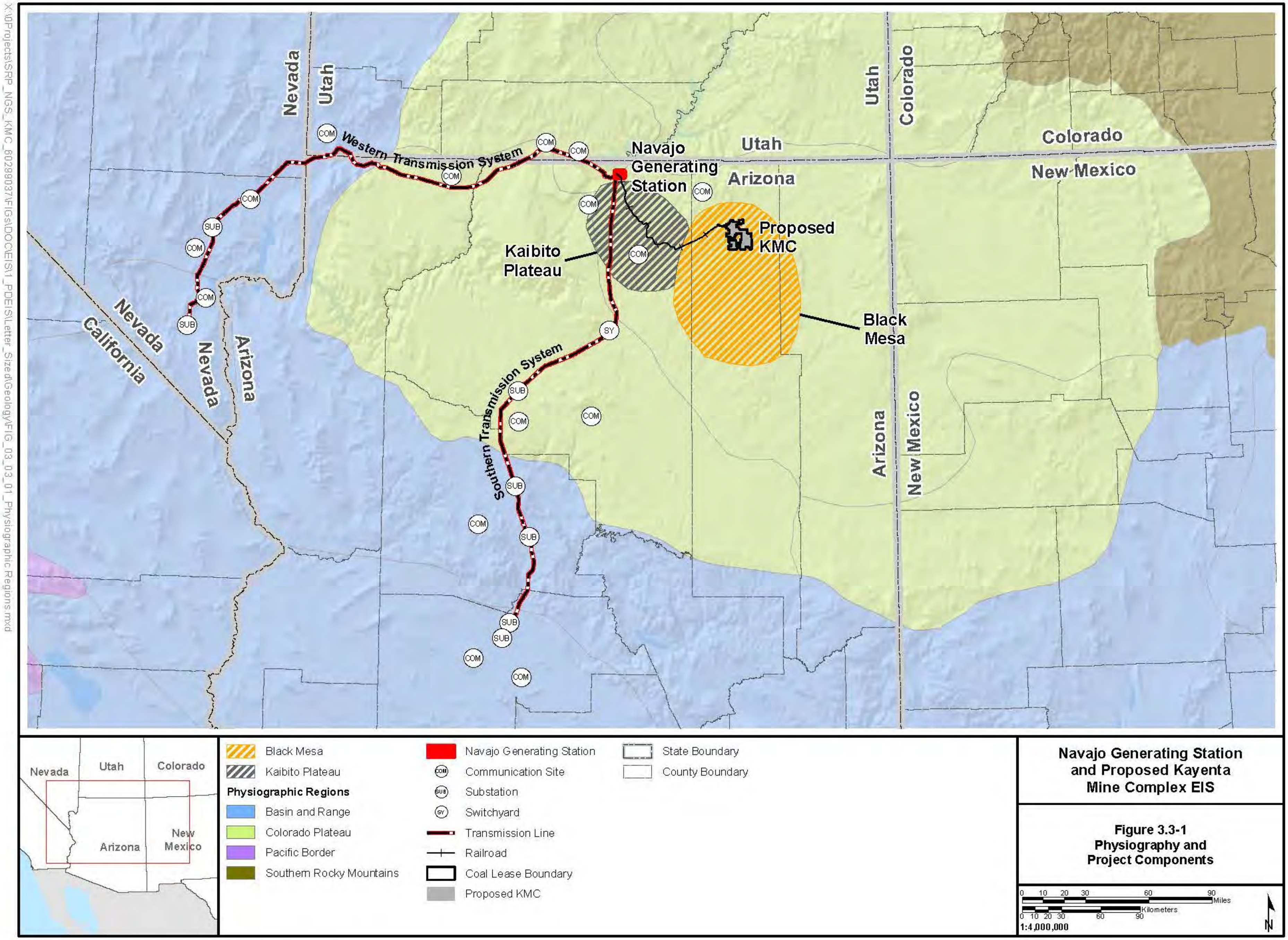
3.3.2.2 Cumulative

The cumulative effects study area is the same as the study area because direct and indirect effects due to the proposed project are not likely to combine with other effects beyond the Proposed Action study area.

3.3.3 Affected Environment

The NGS facilities are located in the Colorado Plateau physiographic province which is typified by gently dipping sedimentary strata that have been sculpted by erosion to form mesas and plateaus (**Figure 3.3-1**). In addition to sedimentary rock, there are areas of igneous rocks. The major physiographic features in the analysis area are the Black Mesa and the Kaibito Plateau (Trapp and Reynolds 1995). Unconsolidated surficial deposits consist of alluvium and sand dunes (Billingsley and Priest 2013). No unusual or unique geologic features were identified.

The Black Mesa is a physiographic feature that is part of a Laramide structural basin referred to as the Black Mesa Basin (Nations et al. 2000). The physiographic mesa is composed of Upper Cretaceous rocks. The mesa is roughly 60 miles long and 50 miles wide and is bounded by steep escarpments and cliffs on the northeast and northwest sides with elevations ranging from 6,000 feet above mean sea level on the southwest side to 8,000 feet above mean sea level on the northeast side. The Kayenta Mine is located on the north end of Black Mesa.



Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 3.3-1
Physiography and Project Components

The Kaibito Plateau is a low relief feature that extends from the Page, Arizona, area to the Black Mesa. The Kaibito Plateau trends northwest to southeast and is approximately 50 miles long and 25 miles wide. Elevations of the Kaibito Plateau range from approximately 3,900 feet above mean sea level at Lake Powell to almost 7,000 feet above mean sea level at the south end of the plateau. Most of the relief is on the west side of the plateau where the Echo Cliffs form the western boundary of the plateau (Wanek and Stephens 1953). The bedrock on the Kaibito Plateau primarily is the Jurassic Navajo Sandstone, Page Sandstone, and the Carmel Formation, but also exposed on the east side of the plateau is the Jurassic Entrada Sandstone. Structurally, the plateau is a syncline referred to as the Kaibito Saddle or Basin and is part of a larger synclinal structure that includes the Black Mesa Basin and extends northwestward to the Kaiparowits Basin in Utah (Kelley 1958; Nations et al. 2000).

In the study areas there are rocks ranging in age from Precambrian to Holocene. **Figures 3.3-2** and **3.3-3** show the geologic units that outcrop in the vicinity of the NGS and proposed KMC. Older Paleozoic and Precambrian rocks are not shown in these figures because they are buried too deep and are not exposed on the surface in this area and therefore, are not relevant to this analysis. Tertiary rocks generally are absent with a few exceptions and it is believed that the Tertiary formations were eroded during regional uplift that occurred in late Tertiary (Cooley et al. 1969). Tertiary rocks that are present consist of conglomerate, sandstone, mudstone, siltstone, and gypsum (Arizona Geological Survey 2015a). Erosion during the Tertiary also removed a large amount of Cretaceous and Jurassic rocks. The Black Mesa is an erosional remnant of Cretaceous rocks that were not removed.

Within both the Kaibito and Black Mesa Basins are small scale folds that generally trend northwest to southeast. There are a few faults mapped in exposed bedrock that trend either northwest-to-southeast or northeast-to-southwest. No Quaternary or potentially active faults have been identified in the Black Mesa or Kaibito Plateau (U.S. Geological Survey and Arizona Geological Survey 2006). A fault is considered active if movement can be determined in the last 10,000 years (Holocene epoch) (U.S. Geological Survey 2012). Seismic activity in the area generally is low. An earthquake catalog search indicated that within a search radius of 100 miles of the NGS-KMC area, there were 82 events since 1973. Of these events, 81 were less than 4.0 magnitude. Only one event measured 4.0 on the Richter Scale (U.S. Geological Survey 2015). There is a low probability of strong ground motion if a maximum credible earthquake were to occur in the vicinity. Horizontal ground motions are expected to be less than 16 percent of the acceleration gravity with a 2 percent probability of exceedance in 50 years or there is a 2 percent chance of exceedance of the highest horizontal acceleration shown on the seismic hazards map or a 98 percent probability that a given area would not experience one exceedance of the maximum acceleration in 50 years or once in 2,475 years (Petersen et al. 2015).

Landslides are common in the Colorado Plateau area and generally occur as a result of erosional undercutting of resistant layers of rocks that cap mesas and plateaus and which are underlain by material that is more easily eroded than the cap rock (Radbruch-Hall et al. 1982). Block-landslides that are present along the sides and bases of mesas and plateaus are indicative of a high incidence of landslides in these areas. Medium- to high-incidence areas are present along the perimeter of the Black Mesa where blocks of sandstone have slid down the sides of the mesa (Conway 2014). Also, the Black Mesa is the location of a particular kind of large mass-movement of rock and soil that is called a Toreva-Block. This type of movement occurs when a large, single mass of material rotates backwards (towards the cliff) as it falls (Reiche 1937). Toreva-Block slides are present on the south side of Black Mesa and the slides are named after proximity to the Town of Toreva, Arizona, and involve rocks of the Mesaverde and Mancos formations. The slides are very large, up to 2,000 feet in length and 500 or more feet in width. Large slides are located 4 miles north of Blue Gap where blocks of Toreva Formation have collapsed where the underlying Mancos Shale was probably eroded. Blue Gap is located about 30 miles southeast of the Kayenta Mine.

System	Series	Group	Formation / Unit		Description
Neoggene	Miocene-Holocene		No formal unit names		Unconsolidated deposits including alluvium, dunes, and terraces composed of gravel, sand, silt, and clay. Includes igneous rocks (basalt and andesite).
Cretaceous	Upper Cretaceous	Mesaverde	Yale Point Sandstone		Consists mainly of sandstone, present only at northeast edge of Black Mesa, 200 feet thick.
			Wepo Formation	Upper Member	Both members are composed of primarily of coal, carbonaceous siltstone, and mudstone, and tabular and lenticular sandstone bodies, 200 to 400 feet thick. The members are separated in part by the tongues of the Rough Rock Sandstone of the Mesaverde Group and the Wind Rock Mancos Formation.
				Lower Member	
			Toreva Formation	Upper Member	Coarse sandstone, 25-120 feet thick.
				Middle Member	Carbonaceous siltstones, mudstones, coal, and sandstones; zero to 100 feet thick.
				Lower Member	Fine- to medium grained sandstone, 100 feet thick.
			Mancos Shale		Siltstone and claystone, 475 to 700 feet thick.
			Dakota Formation	Upper Member	Fine-grained sandstone, thickness variable and uncertain.
				Middle Member	Carbonaceous siltstone and coal, 20 to 40 feet thick.
				Lower Member	Medium- to fine-grained sandstone, 30 to 60 feet thick.
Jurassic	Upper Jurassic		Morrison Formation		Sandstone and siltstone, 200 to 600 feet thick
	Middle Jurassic		Wanakah Formation / Cow Springs Sandstone		Sandstone, siltstone, and minor limestone, 180 feet thick.
		San Rafael Group	Entrada Sandstone		Sandstone, minor siltstone, up to 785 feet thick
			Carmel Formation		Siltstone, claystone, and silty calcareous and gypsiferous sandstone, 160 to 240 feet thick.
			Page Sandstone		Fine- to medium-grained sandstone, with thin siltstone. Unconformably overlies similar-appearing Navajo Sandstone east, south, and southwest of Glen Canyon Dam, zero to 300 feet thick.
	Lower Jurassic	Glen Canyon Group	Navajo Sandstone		Fine- to medium grained well sorted sandstone, prominent cliff former; 1,200 to 1,750 feet thick.
			Kayenta Formation (Springdale Sandstone Member)		Fine- to medium-grained sandstone and mudstone, siltstone, and silty sandstone; 240 to 300 feet thick.
			Moenave / Wingate Sandstone		Coarse-grained fluvial siltstones and silty sandstones; 80 to 140 feet thick.
Triassic	Upper Triassic		Chinle Formation		Coarse- to fine-grained sandstone, siltstone, mudstone, and limestone, up to 900 feet thick.
	Lower - Middle Triassic		Moenkopi Formation		Limestone, mudstone, siltstone, coarse grained and conglomeratic sandstone, up to 620 feet.
Permian			Kaibab Formation		Limestone, dolomite, calcareous sandstone, siltstone, 350 feet thick.
			Toroweap Formation		Siltstone, calcareous sandstone, gypsum, limestone and dolomite, up to 220 feet thick.
			Coconino Sandstone		White, cliff-forming quartz sandstone, up to 400 feet thick.
Pennsylvanian			Supai Group		Cliff-forming sandstone, siltstone, mudstone, 825 feet thick.

Sources: Allis et al. 2003; Arizona Geological Survey 2015a; Billingsley and Priest 2013, Condon and Huffman 1988; Cooley et al. 1969; Franczyk 1988; Hintze, 1988; Nations et al. 2000; Peterson and Pipiringos, 1979.

Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 3.3-2

Stratigraphic Chart

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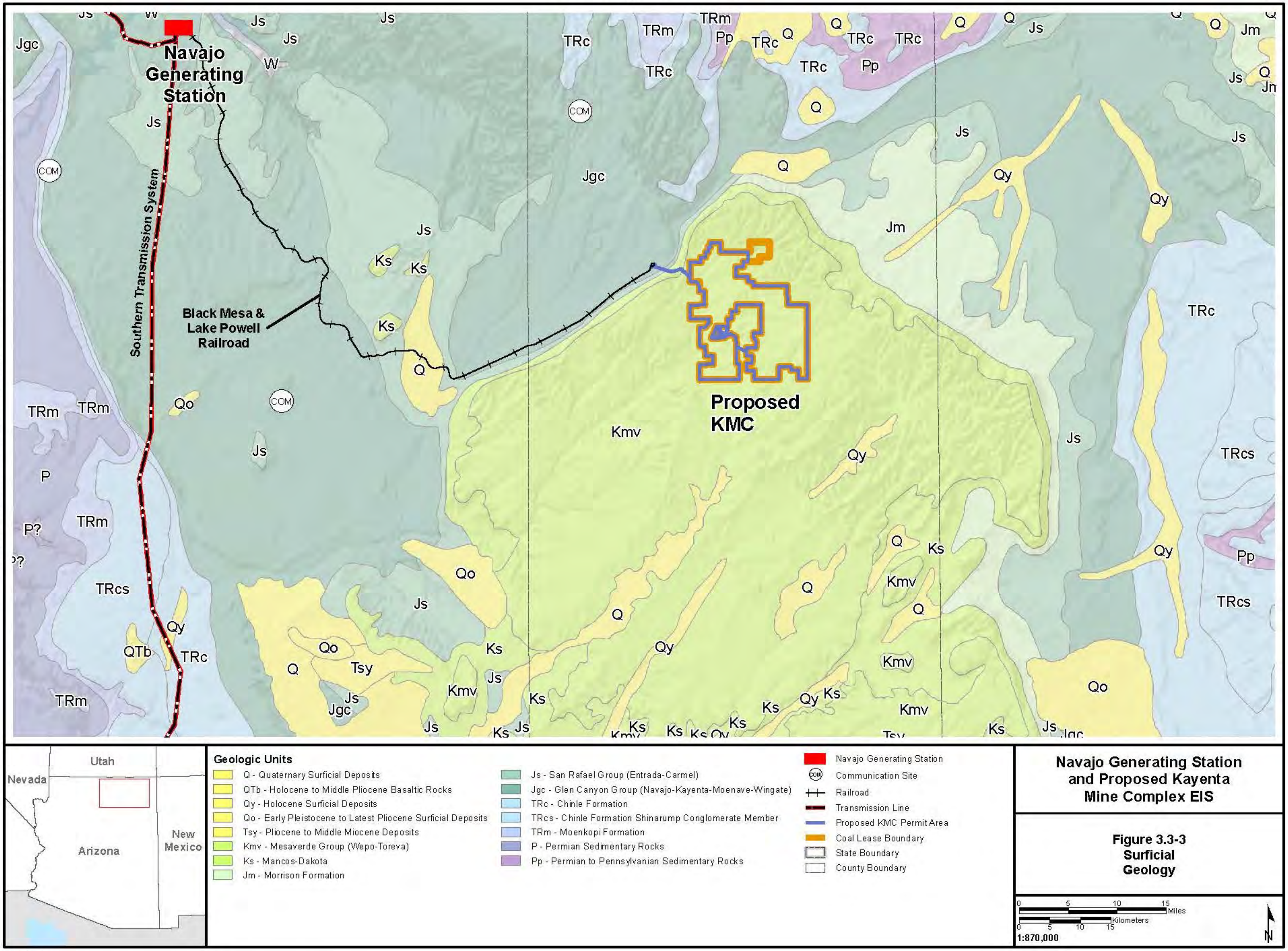


Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 3.3-3 Surficial Geology

7/19/2016

Cracks and sinkholes have been identified at several locations at Black Mesa and likely are attributed to prolonged drought resulting in large desiccation cracks that have been further eroded during precipitation events. According to the Office of Surface Mining Reclamation and Enforcement (OSMRE [2011]), "In 2003 land subsidence features in the form of sinkholes, cracks, and slumps were reported near Forest Lake, about 7 miles south of the Peabody Western Coal Company (PWCC) lease area. After investigation by Office of Surface Mining, Navajo Nation Minerals Department, Navajo Nation Water Resources Department, and U.S. Geological Survey, all of the subsidence features of concern were determined to be either in or adjacent to unconsolidated alluvial valley deposits and due to surface water entering and eroding desiccation features following an extended period of drought. These features are unrelated to the mining or water production facilities on the PWCC lease area. Subsidence and formation of sinkholes in the Navajo Aquifer (N-Aquifer) well field area is considered highly unlikely."

The transmission systems and communication sites are located in the Colorado Plateau and Basin and Range physiographic provinces (**Figure 3.3-1**) (Fenneman 1928). The Basin and Range province is characterized by isolated, block-faulted mountain ranges interspersed among basins or valleys. When the mountains were uplifted during the Tertiary, erosion caused sediment to be shed from the mountains and deposited in the valleys. The mountain ranges generally are oriented northwest-to-southeast and parallel to each other. On the south side of the Colorado Plateau in Arizona there is a transitional area that exhibits characteristics of both provinces such as areas of flat-lying sedimentary rocks and faulted mountain ranges (Rasmussen 2012). The transmission line corridors cross a variety of geologic units from Precambrian to Holocene. Quaternary faults are common in the analysis area, but only a few are considered active. The potential for earthquake-generated ground motion in the analysis area ranges from moderate to low (Petersen et al. 2015). Other geologic hazards that could potentially affect the project facilities are landslides and fissures. The landslide hazard occurs where large slumps and slides can occur along the sides of mesas and escarpments. Fissures occur where extensive groundwater pumping causes subsidence of unconsolidated valley fill materials (Arizona Geological Survey 2015b). Earth fissures would only be expected to affect the most southerly portions of the transmission line corridors in the Phoenix area.

3.3.3.1 Navajo Generating Station

The NGS is located on the northern end of the Kaibito Plateau and the bedrock at the site is composed of the Navajo Sandstone, the Page Sandstone, and the Carmel Formation (Allis et al. 2003; Billingsley and Priest 2013).The Navajo Sandstone, which is Lower Jurassic in age, is part of the Glen Canyon Group that is composed of the Navajo Sandstone, Kayenta Formation, and the Moenave/Wingate Sandstone (**Figure 3.3-2**). The Navajo Sandstone primarily is composed of fine- to medium-grained quartz sandstone and is regionally widespread. The Navajo Sandstone and its equivalents have been identified from southern Nevada, northern Arizona, much of Utah, western Colorado, southern Wyoming, and southeastern Idaho, covering an area of approximately 97,000 square miles (Tape 2005). The Navajo Sandstone was derived from wind-driven sand and is known for its characteristics as a prominent cliff former, large-scale cross bedding, and pale-red and white sandstone. The Navajo Sandstone is reported to be 1,400 feet thick in the NGS facility area and 1,750 feet thick where the Navajo Sandstone is exposed in the walls of the Echo Cliffs on the west side of Kaibito Plateau (Billingsley and Priest 2013).

The Page Sandstone is the lowest member of the San Rafael Group that also is composed of (in ascending order) the Carmel Formation and the Entrada Sandstone (**Figure 3.3-2**). The Page Sandstone looks very similar to and was considered part of the Navajo Sandstone until it was determined that the units are separated by a major regional Jurassic unconformity and that deposition was not continuous from the Navajo Sandstone to the Page Sandstone (Peterson and Pipiringos 1979). The Page Sandstone is very limited in extent and is found in north-central Arizona and south-central Utah. The Page Sandstone is up to 300 feet thick 8 miles south of Page, Arizona, where it is exposed along the Echo Cliffs (Billingsley and Priest 2013). However the Page Sandstone thins rapidly in all directions and occurs as erosional remnants on the Kaibito Plateau, varying from 125 to 250 feet in the vicinity of NGS (Pipiringos and O'Sullivan 1978). The Page sandstone underlies portions of the NGS and facilities, with the plant itself underlain by the Carmel Formation. The coal combustion residuals disposal site, the water pipeline, and the 230-kV electrical transmission line from the pump station to the NGS are located on the Page Sandstone and the Navajo Sandstone (Billingsley and Priest 2013). The lake pumping station and the road between Navajo Nation Route 22B and the pump station are located on the Navajo Sandstone. The coal unloading and storage facilities are located on the Carmel Formation.

The Carmel Formation is composed of siltstone, claystone, and silty calcareous and gypsiferous sandstone, 160 to 240 feet thick (Billingsley and Priest 2013; Wanek and Stephens 1953). It is distinguished from the Navajo and Page Sandstones by its reddish-brown color. The Page Sandstone and Carmel Formation are erosional remnants that form benches on the Navajo Sandstone. The plant site and coal combustion residuals disposal site are located on these benches formed by the Page Sandstone and Carmel Formation. The Carmel Formation is reported to be less than 70 feet thick in the vicinity of NGS (Salt River Project Agricultural Improvement and Power District 2016). The contrast with the reported regional thickness of the Carmel is indicative of possible erosion that has thinned the unit.

From the coal loadout facility heading southwest, the BM&LP Railroad crosses the Klethia Valley that is located between Black Mesa on the southeast and the White and Shonto mesas to the northwest. The Klethia Valley is the location of the Cow Creek Syncline, a trough fold that separates the Black Mesa from the plateaus to the northwest (Nations et al. 2000; Trapp and Reynolds 1995). The train route through the Klethia Valley crosses unconsolidated sand dune deposits and bedrock of the San Raphael and Glen Canyon Groups (Haynes and Hackman 1978). Twenty miles from the loadout, the railroad turns to the northwest and crosses onto the Kaibito Plateau where the route is largely underlain by the Navajo Sandstone until about 10 miles south of the NGS site where the railroad crosses the Carmel Formation to its terminus at the power plant (Billingsley and Priest 2013). Surficial deposits crossed on the Kaibito Plateau consist mainly of sand dunes.

3.3.3.2 Proposed Kayenta Mine Complex

The bedrock at the proposed KMC consists of the upper Cretaceous Dakota Formation, Mancos Shale, and the Mesaverde Group. The Dakota Formation is the stratigraphically lowest geologic unit that forms Black Mesa and is composed of three members as shown on **Figure 3.3-2**. The Dakota is highly variable in thickness and lithology (Nations et al. 2000). The next stratigraphically higher geologic unit is the Mancos Formation which is composed of 475 to 700 feet of siltstone and claystone that is a slope former and is deeply incised in drainages where it is exposed. The Mancos grades upward into the Toreva Formation at the base of the Mesaverde Group. The Toreva Formation consists of three members: a lower sandstone that is a cliff-former, a middle member composed of rocks of highly variable lithology, and an upper sandstone member. The sandstone members are fairly continuous and widespread across Black Mesa, but the middle member thins from south to north where it appears to have been removed by erosion (Nations et al. 2000).

Above the Toreva Formation is the Wepo Formation, which is the primary coal-bearing unit on Black Mesa. The Wepo Formation is composed of upper and lower members that are separated in part by the Wind Rock Tongue of the Mancos Shale and the Rough Rock Sandstone (Franczyk 1988). The members of the Wepo Formation are similar in composition and consist of coal, carbonaceous siltstone, mudstone, and tabular and lenticular sandstone bodies (Nations et al. 2000). The Wepo Formation forms slopes and benches and is exposed on the top and sides of the mesa. The coals in the Wepo are generally found in the undifferentiated part of the formation where the upper and lower members are not separated by the Wind Rock Tongue of the Mancos Shale and the Rough Rock Sandstone. In the northern part of Black Mesa, the Yale Point Sandstone overlies the Wepo Formation. The Yale Point Sandstone was largely removed by erosion, but forms prominent cliffs along the north wall of Black Mesa.

Although there are coals in the other formations that make up Black Mesa, the Wepo Formation coals are the most economic to mine because, on average, the seams are thicker, have the highest quality, and are the most mineable reserves (Nations et al. 2000). The coals occur in seven identified coal zones designated by color and are in ascending order: Orange, Brown, Yellow, Red, Blue, Green, and Violet (PWCC 2012 et seq.). Mineable coals range from 3 to 8 feet thick, but can be as much as 20 feet thick. The net thickness of Wepo coals is 60 feet on the north side of Black Mesa. Net thickness across the mine area varies from 20 to 60 feet (Nations et al. 2000). Coal quality is measured by heat value, sulfur content, and ash content (residue of mineral matter after combustion). The higher heating value and lower sulfur and ash content of the Wepo Formation coals results in generally higher quality coal than coals from the Dakota and Toreva formations. The average coal quality parameters of Wepo Formation coals at the Kayenta Mine are as follows on an as-received basis: heat value of 10,900 British thermal units per pound; sulfur content of 0.5 percent; and ash content of 7.5 percent. The coal is ranked as bituminous to sub-bituminous (Nations et al. 2000). By contrast, the average as received quality parameters for the Dakota Formation coals, on an as-received basis, are heat value of 8,934 British thermal units per pound, sulfur content of 1.3 percent; ash content of 14.9 percent and a ranking of sub-bituminous. Toreva coals averaged, on an as-received basis, a heat value of 9,756 British thermal units per pound, sulfur content of 0.93 percent, ash content 18.75 percent, and a sub-bituminous rank.

3.3.3.3 Transmission Systems and Communication Sites

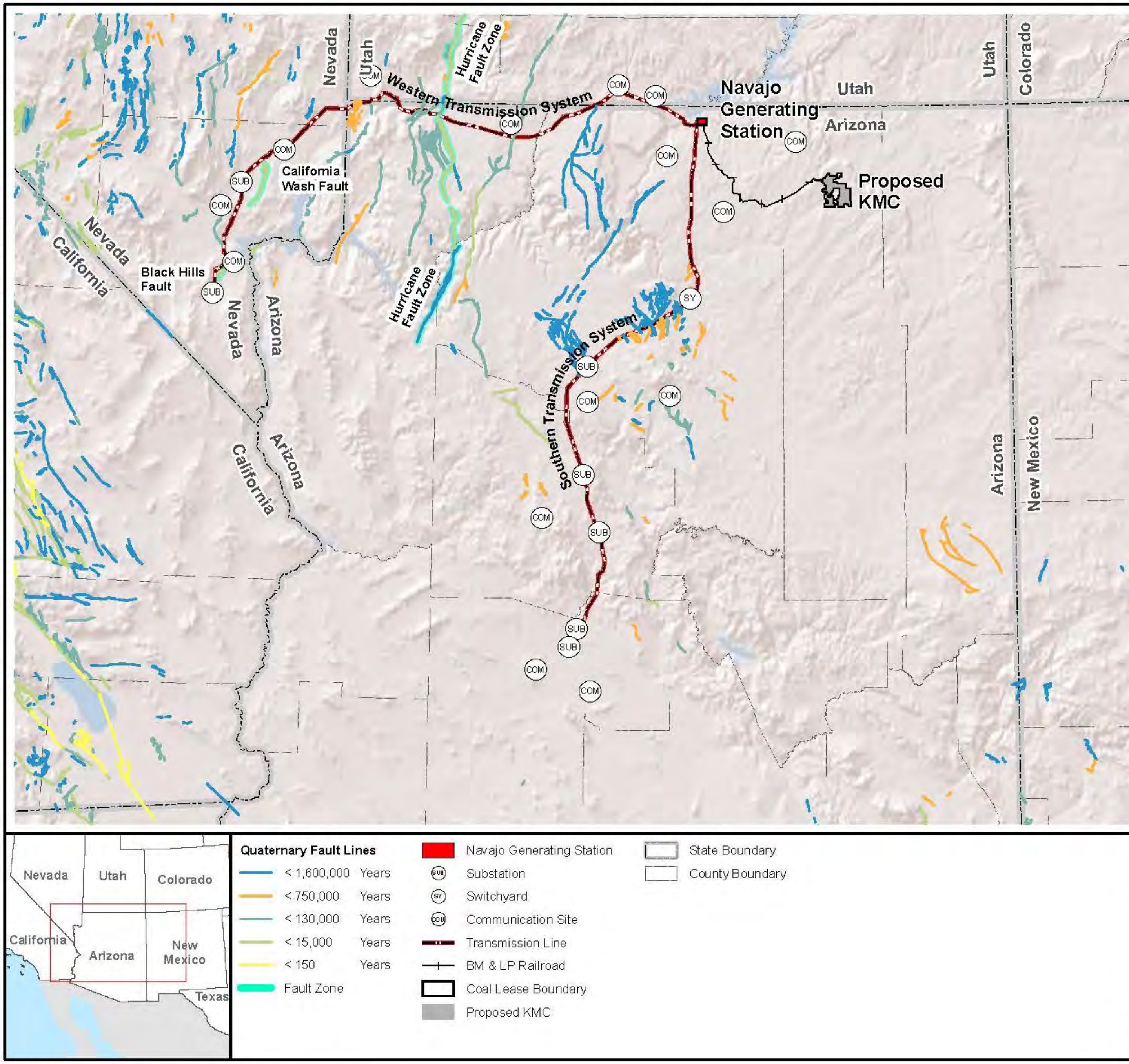
3.3.3.3.1 Western Transmission System

The Western Transmission System (WTS) crosses valley fill deposits, Paleozoic, Triassic and Tertiary sedimentary and volcanic rocks (tuffs and lava flows) (Longwell et al. 1965; Stewart and Carlson 1978). The Paleozoic rocks include the Pennsylvanian-Permian Bird Spring Formation, Permian Coconino Sandstone, and Kaibab Limestone. Triassic rocks include the Chinle, Moenkopi, and Thaynes formations. Tertiary rocks consist of the Muddy Creek and the Miocene Horse Spring formations and undivided volcanic rocks.

The WTS crosses, or is in close proximity to, three major fault zones (**Figure 3.3-4**). The first is the Las Vegas Shear Zone, a major east-west feature that is considered a mid-Cenozoic feature and therefore, is not classified as an active fault (DePolo 2008). Because the Las Vegas Shear zone is not a Quaternary fault, it is not included in the Quaternary Fold and Fault Database (U.S. Geological Survey and Nevada Bureau of Mines and Geology 2006). Another potentially active major fault zone is the California Wash fault that forms the boundary of California Wash and the Muddy Mountains northeast of Las Vegas, Nevada (Anderson 1999a). The fault cuts Holocene material and therefore, is believed to be active. The WTS also crosses the Hurricane fault zone which extends over 100 miles from north to south from the vicinity of Hurricane, Utah, to about 20 miles north of Interstate 40 in Arizona. The Anderson Junction section of the Hurricane fault zone that is crossed by the corridor is considered to be potentially active (Black et al. 2004).

The WTS crosses or is near a small active fault zone located along the southeast base of the Black Hills at the north end of the McCullough Range just southwest of Railroad Pass, southeast of Las Vegas, Nevada. The Black Hills fault zone cuts Holocene deposits that are estimated to be 5,000 years old (Anderson 1999b).

In addition to the potentially active faults that are crossed by the WTS, horizontal ground motions are expected to range from 14 to 30 percent of the acceleration gravity with a 2 percent probability of exceedance in 50 years (Petersen et al. 2015). The strongest ground motions (twenty to thirty percent of the acceleration of gravity) are expected to occur north of Las Vegas where the WTS generally follows the route of Interstate 15 in northeast Clark County, Nevada.



Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 3.3-4

Quaternary Faults

7/19/2016

In late March to early April 2016, a swarm of 18 small earthquakes occurred in northwest Arizona (Conway 2016). The epicenters line up north to south roughly parallel to the Arizona-Nevada state line and are about 30 miles south of the WTS (**Figure 3.3-4**). The magnitudes ranged from 0.7 to 2.6 and no damage or injuries were reported. The swarm is not associated with any identified active faults.

3.3.3.3.2 Southern Transmission System

The Southern Transmission System (STS) is in the Colorado Plateau and Basin and Range provinces and the transitional area between the provinces. The bedrock in the northern portion of the corridor is composed of the San Rafael and Glen Canyon Groups. South of Moenkopi the route turns southwest and skirts the edge of the San Francisco Volcanic field (Arizona Geological Survey 2015a). The bedrock consists of Miocene to Holocene volcanic rocks. Where volcanic rocks are not present, the corridor is underlain by Paleozoic rocks. Further south in the Prescott Valley, the corridor is underlain by Pliocene- and Miocene-aged valley fill deposits. South of the Prescott Valley in the Agua Fria area, the bedrock consists of Precambrian igneous and meta-igneous and Miocene basalts. In the northern outskirts of Phoenix where the corridor terminates, it is underlain by Pleistocene to Holocene valley fill deposits and basalt. The corridor does not cross any active faults (U.S. Geological Survey and Arizona Geological Survey 2006). Horizontal ground motions are expected to be from less than 8 to 16 percent of the acceleration gravity with a 2 percent probability of exceedance in 50 years (Petersen et al. 2015). Fissures are a potential hazard in the north Phoenix area. Although fissures have not been identified in or along the corridor, the Arizona Geological Survey has several fissure study areas close to the corridor (Arizona Geological Survey 2015b). Landslide hazards may be present along mesa walls and escarpments.

3.3.3.3.3 Communication Sites

Table 3.3-1 lists the communication sites and the geologic formations or deposit which underlie each site. No unique geologic formations were identified at the communication sites, nor were any geologic hazards found to be associated with the sites.

Table 3.3-1 Geologic Units at Communication Sites

Site Name	Formation/Unit	Age	Description
Apex to Crystal	Redwall Limestone and Supai Group	Mississippian to Early Permian	Limestone and sandstone
Beaver Dam	Redwall	Mississippian	Limestone and dolomite
Bill Williams	No formation name	Middle Miocene to Pliocene	Rhyolite and dacite
Buckskin Mountain	Toroweap	Early Permian	Limestone and evaporite
Glen Canyon	Dune sand	Quaternary	Sand
Glendale	Muav Limestone	Middle Cambrian to Late Cambrian	Limestone and dolomite
Jack's Peak	Glen Canyon Group	Early Jurassic	Sandstone
Moenkopi	Chinle Formation Shinarump Member	Late Triassic	Sandstone conglomerate
Mount Elden	No formation name	Middle Pliocene to Holocene	Andesite and dacite
Mount Francis	Precambrian	Early Proterozoic	Granite and Granodiorite
Navajo	Glen Canyon Group	Early Jurassic	Sandstone
NGS	Glen Canyon Group	Early Jurassic	Sandstone
Pipe Springs	Glen Canyon Group	Early Jurassic	Sandstone
Preston Mesa	Glen Canyon Group	Early Jurassic	Sandstone
Red Mountain	No formation name	Early Miocene to Early Pliocene	Basalt and andesite

Table 3.3-1 Geologic Units at Communication Sites

Site Name	Formation/Unit	Age	Description
West Phoenix	Unconsolidated material	Middle to Late Pleistocene	Sand and gravel
Westwing	Unconsolidated material	Middle to Late Pleistocene	Sand and gravel
White Tank	Precambrian	Early Proterozoic	Granite and granodiorite
Zilnez Mesa	Glen Canyon Group	Early Jurassic	Sandstone

Source: Arizona Geological Survey 2015b; Stewart and Carlson 1978.

3.3.4 Environmental Consequences

Data from a variety of sources including governmental agencies, academic institutions, other published information, and information from the applicant were reviewed to provide a description of the geologic environment (Section 3.3.5). The description of the geology was used to analyze potential impacts of the alternatives.

3.3.4.1 Issues

The purpose of the Geology and Landforms section is to analyze whether the Proposed Action or alternatives would cause a physical change in surface or subsurface rock characteristics that potentially would damage or destroy unique geologic features or landforms or impacts that result in the exposure of people or structures to geologic hazards. The issues analyzed in this section are listed below.

Issue 1 – Unique Geologic Features

- Potential for damage or destruction to unique geologic features.

Issue 2 – Geologic Hazards

- Potential risk geologic hazards pose to people or structures.

Issue 3 – Geologic Strata or Landform Changes

- Potential for modification of the geologic strata or topography.

Unique geologic features would consist of, for example, hoodoos, arches, bridges, badlands, or cross bedding that have scientific or aesthetic value. The specific threshold for impacts to unique geologic features and landforms would be whether the action would result in a permanent alteration or destruction of unique geologic features or landforms, the loss of which would be considered adverse to science or human experience.

Geologic hazards are “natural processes” that threaten harm to people and property (Creath 1966). The impact threshold for geologic hazards is the degree of risk that such hazards would pose to people and structures due to seismic hazards, landslides or unstable ground or ground fissures.

3.3.4.2 Assumptions and Impact Methodology

It was assumed that no field surveys would be conducted to collect data and that data would be acquired from readily available published or government agency sources or information provided by the NGS

Participants and PWCC. An assumption with regard to the analysis of geologic hazards is that hazard risk would not change from current conditions over the lifetime of the project.

The methodology for analysis of potential impacts is to review the available data and make a determination whether there are any unique geologic features as defined above and if there is a potential that actions would result in impacts to the resource. With regard to geologic hazards, the methodology for analysis includes review of the various geologic sources, determination of what geologic hazards would be present, and disclosure of the level of risk those hazards would pose to the subject facilities and infrastructure.

3.3.4.3 Proposed Action

3.3.4.3.1 Navajo Generating Station

3.3.4.3.1.1 Unique Geologic Features

No impacts to unique geologic features are anticipated as a result of the Proposed Action because no unique features or formations were identified.

3.3.4.3.1.2 Geologic Hazards

Implementation of the Proposed Action would not result in impacts from geologic hazards because no hazards were identified in the vicinity of the NGS and associated facilities including the BM&LP Railroad.

3.3.4.3.1.3 Geologic Strata or Landform Changes

Implementation of the Proposed Action would not result in impacts to geologic strata at NGS. Minor landform changes would occur as a result of expansion of the coal combustion residuals disposal site under the 3-Unit Operation (**Table 2-4**). There would be no need to expand the existing coal combustion residuals disposal site under the 2-Unit Operation.

3.3.4.3.2 Proposed Kayenta Mine Complex

3.3.4.3.2.1 Unique Geologic Features

No impacts to unique geologic features are anticipated as a result of the Proposed Action because no unique features or formations were identified in the vicinity of the proposed KMC.

3.3.4.3.2.2 Geologic Hazards

Implementation of the Proposed Action (3-Unit Operation or 2-Unit Operation) would not result in impacts from geologic hazards. The cracks and accompanying subsidence that have been observed on the Black Mesa are a scoping issue of concern. However, they are not expected to pose a concern to coal mine operations because the cracks are found in alluvial areas and are not associated with mining (OSMRE 2011). Subsidence due to pumping from an aquifer results when the aquifer is compressed as groundwater is withdrawn. As the aquifer is compressed, the ground subsides. Aquifer compression can be estimated by relating the amount of drawdown to the storage coefficient of the aquifer. The storage coefficient is a measure of the amount of water released from storage per unit of surface area of the aquifer per unit change in head (Case et al. 2003; Edgar and Case 2000). The amount of compression of the aquifer is the product of the storage coefficient (dimensionless) and the amount of drawdown (feet). For the N-Aquifer with confined storage coefficients that range from 2.2×10^{-5} to 8.0×10^{-3} (OSMRE 2011) and an expected drawdown of 100 feet (Section 3.7), the amount of compression would range from 0.02 foot to 0.8 foot. For the D-Aquifer with a confined storage coefficient of 3×10^{-7} (Section 3.7) and an expected drawdown of 150 feet, the compression of the aquifer is expected to be 5×10^{-5} foot. Given the small amounts of expected compression in these aquifers, subsidence would not be observed on the surface. The cracks and subsidence that have been observed on Black Mesa are most likely eroded desiccation cracks as described above rather than fissures created by groundwater withdrawal.

The cracks have not resulted from mining activities or groundwater withdrawals related to mining nor are the cracks due to landslides or seismic activity. No impacts to mine facilities due to landslides and seismic events are anticipated.

3.3.4.3.2.3 Geologic Strata or Landform Changes

Because mining would occur under the Proposed Action, removal of overburden material would continue in order to mine the coal. **Table 3.3-2** summarizes the amounts of material (overburden and topsoil) that would be removed under the 3-Unit Operation and 2-Unit Operation. The 2-Unit Operation would have less impact since less coal would be mined resulting in less impact to overburden materials. After the coal is removed, the overburden is backfilled into the pit. The process of extracting the coal would result in direct impacts through permanent disruption of the original strata and a change in topography. The disturbance would be a minor impact since the geologic strata would not be considered unique and the topography would be restored according to regulation. One of the objectives of reclamation is to restore, to the extent possible, the original contours of the land surface prior to mining, including irregularities in the restored surface. In addition to restoring pre-mining topography, the backfill must be stabilized to prevent erosion and provide for a return to pre-mining uses, which in the case of the Kayenta Mine is rangeland grazing, wildlife habitat, and cultural plants (PWCC 2012 et seq.). Erosion of the backfilled areas is a minor, but potential long-term indirect effect. However, erosion control structures and appropriate grading combined with establishment of a diverse and permanent vegetation cover would be used to lessen the effects of erosion (OSMRE 2011; PWCC 2012 et seq.).

Table 3.3-2 Overburden Disturbance: High and Low Production Comparison

	3-Unit Operation (million tpy)	2-Unit Operation (million tpy)
Annual Coal Production	8.1	5.5
Overburden and Topsoil[1]	97	65

[1] Assumes a stripping ratio of 5.1 bank cubic yards of overburden per ton of coal mined (Section 2.3.1.2); 2.35 tons per bank cubic yard (Caterpillar 2015).

tpy = tons per year.

3.3.4.3.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

3.3.4.3.3.1 Unique Geologic Features

No impacts to unique geologic features are anticipated as a result of the Proposed Action because no unique features or formations were identified in the vicinity of the transmission systems and communication sites.

3.3.4.3.3.2 Geologic Hazards

Western Transmission System

The WTS is located in areas (southwestern Utah and southern Nevada) where active faults are located that could generate earthquakes and result in horizontal ground motions of up to 30 percent of the acceleration of gravity. Accelerations of 25 to 30 percent of the acceleration of gravity could result in slight damage to specially designed structures, but there may be considerable damage to ordinary substantial buildings, including partial collapse. Also, there would be much damage to poorly built structures which could cause chimneys, smokestacks, columns, monuments, and walls to fall (Bolt 1993; U.S. Geological Survey 2014).

Electrical transmission system vulnerability to seismic effects depends on which system components are involved. Transmission towers generally survive well in earthquake events since they are lightweight structures at independent locations connected by conductors that have the ability to adjust to the vibrations of ground motion (Rocky Mountain Power 2010). In addition, the towers are built to a standard for wind and ice structural loading and as such, exceed earthquake design loads (American Society of Civil Engineers 1991). However, transmission structures are at a somewhat greater risk when built on soils prone to liquefaction. Liquefaction potential exists where water tables are high and the soils are loose and sandy, but no liquefaction-prone areas were identified. Other facilities such as substations and associated equipment such as ceramic insulators do not fare well unless specific design considerations are built in or are retrofitted to existing facilities (Yokel 1990).

The transmission systems were constructed before the U.S. Geological Survey and state geological surveys began comprehensive research programs to determine which young faults (less than 1.6 million years old) had the potential to be active sources for strong earthquakes. As described in Section 3.3.1.4, the WTS crosses over or is close to faults that have been determined to be active. As described in the previous paragraph, transmission systems are likely to withstand seismic motions. The seismic hazards represent a direct, minor impact to the WTS. The seismic hazards are not contingent on either option of 3-Unit Operation or 2-Unit Operation.

The WTS would not impact any unique geologic resources and no other geologic hazards were identified that would affect the corridor.

<u>Southern Transmission System</u>

The STS does not cross any faults that have been determined to be active. Seismic hazard mapping indicates that there is low potential for strong ground motions to affect the transmission line corridor and associated substations. Although ground fissures have been mapped a few miles from the corridor terminus north of Phoenix, the possibility exists that such hazards have yet to be manifested since the mechanisms of fissure formation are part of a dynamic process (groundwater withdrawal from unconsolidated valley fill). The potential hazards from fissure formation would be negligible and are not dependent upon 3-Unit Operation or 2-Unit Operation.

<u>Communication Sites</u>

No geologic hazards were identified in the vicinity of the communication sites.

3.3.4.3.3.3 Geologic Strata or Landform Changes

Implementation of the Proposed Action would not result in impacts to geologic strata or landforms as there is no new construction planned for the transmission system or communication sites.

3.3.4.3.4 Project Impact Summary – All Project Components

There would be no impacts to unique geologic features because no such features were identified in the course of the analysis.

There would be no direct impacts to project components from geologic hazards for the NGS and associated facilities, the proposed KMC, and the communication sites. Based on the low seismicity and the absence of identified active source faults, the NGS and associated facilities, the proposed KMC, and the communication sites are not likely to experience damaging earthquake-generated ground motions. The WTS has a minor risk of being affected by seismicity because of its proximity to active faults and areas of higher potential ground motion. The STS has a negligible risk of fissure formation near the terminus north of Phoenix. No other geologic hazards were identified for the project components.

There would be no impacts to geologic strata and topography for most of the NGS site and associated facilities, transmission system, and communication sites. Minor landform changes would occur at the coal combustion residual disposal area at NGS as a result of expansion of the coal combustion residuals disposal site under the 3-Unit Operation only. Direct impacts to landforms at the proposed KMC would be minor since reclamation requirements call for restoring the topography as close to pre-mining conditions as possible.

3.3.4.3.5 Cumulative Impacts

The proposed Manymules water development project is a foreseeable action in the Kayenta mine area. The project includes 46 miles of water pipeline, two water treatment units, pump stations, and water storage in Kayenta mine using well water obtained from PWCC (OSMRE 2011). The Manymules project would have negligible impacts to topography and not contribute to cumulative impacts.

3.3.4.4 Natural Gas Partial Federal Replacement Alternative

Under the Natural Gas Partial Federal Replacement (PFR) Alternative, a selected quantity of power between 100 megawatts (MW) and 250 MW would be contracted for under a long-term power purchase agreement from currently unidentified, existing natural gas generation sources, displacing an equivalent amount of power from the federal share of NGS generation. Because the facility is assumed to currently exist, prior disturbance impacts to unique geologic resources and landforms are not evaluated. The following are key assumptions related to such an existing site:

- Prior impacts to unique geologic features and landform changes are not assessed in this discussion.
- Geologic hazard risks are not assessed in this discussion.
- Whatever the level of geologic hazard risks, those risks would not appreciably change from 2020 to 2044.

Impact issues for the Natural Gas PFR Alternative are discussed across the range of NGS unit operations (3-Unit and 2-Unit) and associated alternative power reductions (100 MW and 250 MW) from the least NGS power reduction to the greatest. Reductions in NGS power generation would proportionally reduce the quantity of coal delivered from the Kayenta Mine.

This discussion distinguishes differences in impacts within the natural gas replacement alternative operational range to provide a basis for comparison with the Proposed Action.

3.3.4.4.1 Navajo Generating Station

3.3.4.4.1.1 Unique Geologic Features

As with the Proposed Action, under the Natural Gas PFR Alternative there would be no impacts to unique geologic features because no such features have been identified at the NGS site.

3.3.4.4.1.2 Geologic Hazards

As with the Proposed Action, under the Natural Gas PFR Alternative there would be no impacts due to geologic hazards because no hazards were identified in the vicinity of the NGS and associated facilities including the BM&LP Railroad.

3.3.4.4.1.3 Geologic Strata or Landform Changes

As with the Proposed Action, under the Natural Gas PFR Alternative there would be no impacts to geologic strata at NGS. Minor landform changes would occur as a result of expansion of the coal combustion residuals disposal site under the 3-Unit Operation for both the 100-MW and 250-MW replacement options. These landform changes would be less than under the Proposed Action due the overall reduction in coal combustion residuals. There would be no need to expand the existing coal combustion residuals disposal site under the 2-Unit Operation for the 100-MW and 250-MW options.

3.3.4.4.2 Proposed Kayenta Mine Complex

If 100 MW to 250 MW of power generation were replaced at NGS by natural gas alternative sources, the proposed KMC would mine less coal. For the 3-Unit Operation, 7.7 million tpy would be mined at the 100-MW natural gas replacement option and 7.1 million tpy under the 250-MW replacement option. For the 2-Unit Operation 5.1 million tpy would be mined under the 100-MW natural gas replacement option and 4.5 million tpy would be mined under the 250-MW option.

3.3.4.4.2.1 Unique Geologic Features

As with the Proposed Action, there would be no impacts to unique geologic features because no such features have been identified at the proposed KMC.

3.3.4.4.2.2 Geologic Hazards

There would be no impacts due to geologic hazards because no hazards were identified in the vicinity of the proposed KMC.

3.3.4.4.2.3 Geologic Strata or Landform Changes

Impacts to overburden and landform changes would be minor but slightly less than the Proposed Action since less coal would be mined which would result in less overall disturbance. **Table 3.3-3** shows the amount of overburden that would be disturbed under the Natural Gas PFR Alternative and other PFR alternatives as compared to the Proposed Action, 3-Unit Operation and 2-Unit Operation. The Natural Gas PFR Alternative would disturb less overburden as compared to the Proposed Action. As would be expected, there are large reductions in disturbance when comparing the 3-Unit Operation and 2-Unit Operation because the one-third reduction in coal that is mined would result in a commensurate reduction in overburden that is disturbed. There are smaller differences between the 100-MW and 250-MW scenarios. From 2040 to 2044, the stripping ratio is expected to increase from 5.1 to 7.1 bank cubic yards of overburden per ton of coal mined (Section 2.3.1.2). The stripping ratio for the last few years of operation would increase the overall overburden disturbance, but the relative differences between action alternatives would not be expected to change.

Table 3.3-3 Proposed KMC Annual Coal Production and Annual Overburden Disturbance

		Proposed Action	Natural Gas PFR		Renewable PFR		Tribal PFR	
			100 MW	250 MW	100 MW	250 MW	100 MW	250 MW
NGS 3-Unit Operation	Annual Coal Production (million tpy)	8.1	7.7	7.1	7.9	7.5	7.9	7.7
	Overburden[1] (million tpy)	97	92.5	85.5	94.4	90.3	95.2	92.3

Table 3.3-3 Proposed KMC Annual Coal Production and Annual Overburden Disturbance

		Proposed Action	Natural Gas PFR		Renewable PFR		Tribal PFR	
			100 MW	250 MW	100 MW	250 MW	100 MW	250 MW
NGS 2-Unit Operation	Annual Coal Production (million tpy)	5.5	5.1	4.5	5.3	4.9	5.3	5.1
	Overburden[1] (million tpy)	65.0	61.3	54.4	63.2	59.1	64.0	61.1

[1] Assumes a stripping ratio of 5.1 bank cubic yards of overburden per ton of coal mined (Section 2.3.1.2, **Table 3.3-2**); 2.35 tons per bank cubic yard.

tpy = tons per year.

3.3.4.4.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

3.3.4.4.3.1 Unique Geologic Features

As with the Proposed Action, there would be no impacts to unique geologic features under the Natural Gas PFR Alternative because no such features have been identified within the transmission systems corridors or communication sites.

3.3.4.4.3.2 Geologic Hazards

As with the Proposed Action, there would be no direct impacts to project components from geologic hazards for the STS and the communication sites. Based on the low seismicity and the absence of identified active source faults, the STS and the communication sites are not likely to experience damaging earthquake-generated ground motions. The WTS has a minor risk of being affected by seismicity because of its proximity to active faults and areas of higher potential ground motion. The STS has a negligible risk of fissure formation near the terminus north of Phoenix.

3.3.4.4.3.3 Geologic Strata or Landform Changes

There would be no impacts to geologic strata or landform changes for the exiting transmission systems and communication sites because no changes would occur due to the implementation of the Natural Gas PFR Alternative.

3.3.4.4.4 Project Impact Summary – All Project Components

As with the Proposed Action, there would be no impacts to unique geologic features since no such features were identified in the course of the analysis.

As with the Proposed Action, there would be no direct impacts to project components from geologic hazards for the NGS and associated facilities, the proposed KMC, and the communication sites. Based on the low seismicity and the absence of identified active source faults, the NGS and associated facilities, the proposed KMC, and the communication sites are not likely to experience damaging earthquake-generated ground motions. The WTS has a minor risk of being affected by seismicity because of its proximity to active faults and areas of higher potential ground motion. The STS has a negligible risk of fissure formation near the terminus north of Phoenix. No other geologic hazards were identified for the project components.

Overall there would be no impacts to geologic strata and landforms for most of the NGS site and associated facilities, transmission system, and communication sites. Minor landform changes would occur at the coal combustion residual disposal area at NGS as a result of expansion of the coal combustion residuals disposal site under the 3-Unit Operation, 100 MW and 250 MW options. These landform changes would be less than under the Proposed Action due the overall reduction in coal combustion residuals. Direct impacts to geologic strata and landform changes of the overburden at the proposed KMC would be minor, but less than the Proposed Action, since reclamation requirements call for restoring the landform changes as close to pre-mining conditions as possible.

3.3.4.4.5 Cumulative Impacts

No reasonably foreseeable future actions are expected to occur that would intersect with the cumulative effects study area for geology and landforms as defined in Section 3.3.2. Because there would be no impacts from reasonably foreseeable future actions, no cumulative impacts are expected to occur.

3.3.4.5 Renewable Partial Federal Replacement Alternative

Under the Renewable PFR Alternative, a selected quantity of power between 100 MW and 250 MW would be contracted for under a long-term power purchase agreement from a currently unidentified, existing renewable energy power source, displacing an equivalent amount of power from the federal share of NGS generation. As with the Natural Gas PFR Alternative, because the facility is assumed to currently exist, prior disturbance impacts to unique geologic resources and landforms are not evaluated. The following are key assumptions related to such an existing site:

- Prior impacts to unique geologic features and landform changes and are not assessed in this discussion.
- Geologic hazard risks are not assessed in this discussion.
- Regardless of the level of geologic hazard risks, those risks would not appreciably change from 2020 to 2044.

Impact issues for the Renewable PFR Alternative are discussed across the range of NGS unit operations (3-Unit and 2-Unit) and associated alternative power reductions (100 MW and 250 MW) from the least NGS power reduction to the greatest. Reductions in NGS power generation would proportionally reduce the quantity of coal delivered from the Kayenta Mine.

This discussion distinguishes differences in impacts within the Renewable PFR Alternative operational range to provide a basis for comparison with the Proposed Action.

The following discusses the impacts to geology and landforms if 100 MW to 250 MW of power generation were replaced at NGS by alternative power purchased from an unknown, but existing source of power from renewable energy. As the site is assumed to be an existing facility, prior disturbance impacts to geology and landforms are not evaluated.

3.3.4.5.1 Navajo Generating Station

3.3.4.5.1.1 Unique Geologic Features

As with the Proposed Action, there would be no impacts to unique geologic features under the Renewable PFR Alternative because no such features have been identified at the NGS site.

3.3.4.5.1.2 Geologic Hazards

As with the Proposed Action, there would be no impacts due to geologic hazards under the Renewable PFR Alternative because no hazards were identified in the vicinity of the NGS and associated facilities including the BM&LP Railroad.

3.3.4.5.1.3 Geologic Strata or Landform Changes

As with the Proposed Action, under the Renewable PFR Alternative there would be no impacts to geologic strata at NGS. Minor landform changes would occur as a result of expansion of the coal combustion residuals disposal site under the 3-Unit Operation for both the 100-MW and 250-MW replacement options. These landform changes would be less than under the Proposed Action due the overall reduction in coal combustion residuals. There would be no need to expand the existing coal combustion residuals disposal site under the 2-Unit Operation for the 100-MW and 250-MW options.

3.3.4.5.2 Proposed Kayenta Mine Complex

If 100 MW to 250 MW of power generation were replaced at NGS by renewable sources, the proposed KMC would mine less coal. For the 3-Unit Operation, 7.9 million tpy would be mined under the 100-MW replacement option and 7.5 million tpy under the 250-MW replacement option. For the 2-Unit Operation 5.3 million tpy would be mined under the 100-MW option and 4.9 million tpy would be mined under the 250-MW option.

3.3.4.5.2.1 Unique Geologic Features

As with the Proposed Action, there would be no impacts to unique geologic features under the Renewable PFR Alternative because no such features have been identified at the proposed KMC.

3.3.4.5.2.2 Geologic Hazards

As with the Proposed Action, there would be no impacts due to geologic hazards under the Renewable PFR Alternative because no hazards were identified in the vicinity of the proposed KMC.

3.3.4.5.2.3 Geologic Strata or Landform Changes

Impacts to overburden and landform changes would be minor but slightly less than the Proposed Action since less coal would be mined which would result in less overall disturbance. **Table 3.3-3** shows the amount of overburden that would be disturbed under the Renewable PFR Alternative and other PFR alternatives as compared to the Proposed Action, 3-Unit Operation and 2-Unit Operation. The Renewable PFR Alternative would disturb less overburden as compared to the Proposed Action. However, the Renewable PFR Alternative would disturb more overburden in comparison to the Natural Gas PFR Alternative, since more coal would be mined.

3.3.4.5.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

3.3.4.5.3.1 Unique Geologic Features

As with the Proposed Action, there would be no impacts to unique geologic features under the Renewable PFR Alternative because no such features have been identified within the transmission systems corridors or communication sites.

3.3.4.5.3.2 Geologic Hazards

As with the Proposed Action, there would be no direct impacts to the STS and communication sites from geologic hazards. Based on the low seismicity and the absence of identified active source faults, the STS and the communication sites are not likely to experience damaging earthquake-generated ground motions. The WTS has a minor risk of being affected by seismicity because of its proximity to active faults and areas of higher potential ground motion. The STS has a negligible risk of fissure formation near the terminus north of Phoenix.

3.3.4.5.3.3 Geologic Strata or Landform Changes

There would be no impacts to geologic strata or landform changes for the exiting transmission systems and communication sites because no changes would occur due to the implementation of the Renewable PFR Alternative.

3.3.4.5.4 Project Impact Summary – All Project Components

As with the Proposed Action, there would be no impacts to unique geologic features since no such features were identified in the course of the analysis.

As with the Proposed Action, there would be no direct impacts to project components from geologic hazards for the NGS and associated facilities, the proposed KMC, and the communication sites. Based on the low seismicity and the absence of identified active source faults, the NGS and associated facilities, the proposed KMC, and the communication sites are not likely to experience damaging earthquake-generated ground motions. The WTS has a minor risk of being affected by seismicity because of its proximity to active faults and areas of higher potential ground motion. The STS has a negligible risk of fissure formation near the terminus north of Phoenix.

Overall there would be no impacts to geologic strata and landforms for most of the NGS site and associated facilities, transmission system, and communication sites. Minor landform changes would occur at the coal combustion residual disposal area at NGS as a result of expansion of the coal combustion residuals disposal site under the 3-Unit Operation, 100 MW and 250 MW options. These landform changes would be less than under the Proposed Action due the overall reduction in coal combustion residuals. Direct impacts to geologic strata and landform changes of the overburden at the KMC would be minor, but less than the Proposed Action, since reclamation requirements call for restoring the landform changes as close to pre-mining conditions as possible.

3.3.4.5.5 Cumulative Impacts

No reasonably foreseeable actions are expected to occur that would intersect with the cumulative effects study area for geology and landforms as defined in Section 3.3.2. Because there would be no impacts from reasonably foreseeable future actions, no cumulative impacts are expected to occur.

3.3.4.6 Tribal Partial Federal Replacement Alternative

Under the Tribal PFR Alternative, between 100 MW and 250 MW of power generation from the NGS would be replaced by power supplied by a new photovoltaic generation facility on tribal land, displacing an equivalent amount of power from the federal share of NGS generation. The construction of a new photovoltaic generation site on tribal land would result in between 1,200 and 3,000 acres of new surface disturbance. The Tribal PFR facility would be analyzed in a separate NEPA process once a facility location is identified. The following discussion relates to impacts to the existing facilities.

3.3.4.6.1 Navajo Generating Station

3.3.4.6.1.1 Unique Geologic Features

Under the Tribal PFR Alternative there would be no impacts to unique geologic features because no such features have been identified at the NGS site.

3.3.4.6.1.2 Geologic Hazards

As with the Proposed Action, there would be no impacts due to geologic hazards because no hazards were identified in the vicinity of the NGS and associated facilities including the BM&LP Railroad.

3.3.4.6.1.3 Geologic Strata or Landform Changes

As with the Proposed Action, under the Tribal PFR Alternative there would be no impacts to geologic strata at NGS. Minor landform changes would occur as a result of expansion of the coal combustion residuals disposal site under the 3-Unit Operation for both the 100-MW and 250-MW replacement options. These landform changes would be less than under the Proposed Action due the overall reduction in coal combustion residuals. There would be no need to expand the existing coal combustion residuals disposal site under the 2-Unit Operation for the 100-MW and 250-MW options.

3.3.4.6.2 Proposed Kayenta Mine Complex

If 100 MW to 250 MW of power generation were replaced at NGS by alternative sources purchased by Bureau of Reclamation (Reclamation) from a new photovoltaic generation site on tribal land, there would be less coal mined at the proposed KMC.

3.3.4.6.2.1 Unique Geologic Features

As with the Proposed Action, there would be no impacts to unique geologic features because no such features have been identified at the proposed KMC.

3.3.4.6.2.2 Geologic Hazards

As with the Proposed Action, there would be no impacts due to geologic hazards because no hazards were identified in the vicinity of the proposed KMC.

3.3.4.6.2.3 Geologic Strata or Landform Changes

Impacts to overburden and landform changes would be minor but slightly less than the Proposed Action since less coal would be mined which would result in less overall disturbance. **Table 3.3-3** shows the amount of overburden that would be disturbed under the Tribal PFR alternatives as compared to the Proposed Action, 3-Unit Operation and 2-Unit Operation. However, the Tribal PFR Alternative would disturb more overburden in comparison to the other PFR alternatives, because more coal would be mined.

3.3.4.6.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

3.3.4.6.3.1 Unique Geologic Features

As with the Proposed Action, there would be no impacts to unique geologic features under the Tribal PFR Alternative because no such features have been identified within the transmission systems corridors or communication sites.

3.3.4.6.3.2 Geologic Hazards

As with the Proposed Action, there would be no direct impacts to the STS and communication sites. Based on the low seismicity and the absence of identified active source faults, the STS and the communication sites are not likely to experience damaging earthquake-generated ground motions. The WTS has a minor risk of being affected by seismicity because of its proximity to active faults and areas of higher potential ground motion. The STS has a negligible risk of fissure formation near the terminus north of Phoenix.

3.3.4.6.3.3 Geologic Strata or Landform Changes

There would be no impacts to geologic strata or landform changes for the exiting transmission systems and communication sites. Any changes resulting from tie-in to the existing transmission system for the new photovoltaic power source would be addressed in a separate NEPA action.

3.3.4.6.4 Project Impact Summary – All Project Components

As with the Proposed Action, there would be no impacts to unique geologic features since no such features were identified in the course of the analysis.

As with the Proposed Action, there would be no direct impacts to project components from geologic hazards for the NGS and associated facilities, the proposed KMC, and the communication sites. Based on the low seismicity and the absence of identified active source faults, the NGS and associated facilities, the proposed KMC, and the communication sites are not likely to experience damaging earthquake-generated ground motions. The WTS has a minor risk of being affected by seismicity because of its proximity to active faults and areas of higher potential ground motion. The STS has a negligible risk of fissure formation near the terminus north of Phoenix.

Overall there would be no impacts to geologic strata and landforms for most of the NGS site and associated facilities, transmission system, and communication sites. Minor landform changes would occur at the coal combustion residual disposal area at NGS as a result of expansion of the coal combustion residuals disposal site under the 3-Unit Operation, 100 MW and 250 MW options. These landform changes would be less than under the Proposed Action due the overall reduction in coal combustion residuals. Direct impacts to geologic strata and landform changes of the overburden at the KMC would be minor, but less than the Proposed Action, because reclamation requirements call for restoring the landform changes as close to pre-mining conditions as possible. The landform changes under the Tribal PFR Alternative would be greater than under other PFR alternatives.

3.3.4.6.5 Cumulative Impacts

No reasonably foreseeable actions are expected to occur that would intersect with the cumulative effects study area for geology and landforms as defined in Section 3.3.2. Because there would be no impacts from reasonably foreseeable future actions, no cumulative impacts are expected to occur.

3.3.4.7 No Action

3.3.4.7.1 Navajo Generating Station

3.3.4.7.1.1 Unique Geologic Features

Under the No Action Alternative, no impacts to unique geologic resources are expected to occur because no unique geologic features have been identified for the NGS.

3.3.4.7.1.2 Geologic Hazards

Geologic hazards would not be a concern because the plant and associated facilities, including the BM&LP Railroad, would be decommissioned and the sites reclaimed. Based on the low seismicity of the area and the absence of identified active source faults the site and railroad are not likely to experience damaging earthquake-generated ground motions. No other geologic hazards were identified at the site.

3.3.4.7.1.3 Geologic Strata or Landform Changes

Under the No Action Alternative the NGS site and BM&LP Railroad would be reclaimed. There would be no impacts to geologic strata and negligible landform changes as a result of the reclamation activities.

3.3.4.7.2 Proposed Kayenta Mine Complex

3.3.4.7.2.1 Unique Geologic Features

Under the No Action Alternative, no impacts to unique geologic resources are expected to occur because no unique geologic features have been identified for the proposed KMC.

3.3.4.7.2.2 Geologic Hazards

There would be no impacts due to geologic hazards because no hazards were identified in the vicinity of the proposed KMC site.

3.3.4.7.2.3 Geologic Strata or Landform Changes

Under the No Action Alternative, no impacts to geologic strata or landform changes are expected. Mining would cease and the disruption of overburden strata would cease. The disturbed areas would be reclaimed to the approximate pre-mining landforms.

3.3.4.7.3 Transmission Systems and Communication Sites

In the event it is determined that some or all of the transmission systems and communication site ROWs are not renewed, a lengthy study and permitting process would need to occur before any decommissioning is initiated due to the essential and integral nature of these facilities with the western electric grid. As noted in Section 2.3.3, up to 4,826 acres within and alongside the transmission system corridors could be temporarily disturbed if the entirety of the transmission systems and communication sites were decommissioned and removed resulting in minor, localized emissions impacts.

3.3.4.7.3.1 Unique Geologic Features

Under the No Action Alternative, no impacts to unique geologic resources are expected to occur because no unique geologic features have been identified for the transmission systems and communications sites.

3.3.4.7.3.2 Geologic Hazards

Since the transmission line systems would continue to operate under the No Action Alternative, the potential impacts and risks due to geologic hazards would continue. There would be no direct impacts to the STS and communication sites. Based on the low seismicity and the absence of identified active source faults, the STS and the communication sites are not likely to experience damaging earthquake-generated ground motions. The WTS has a minor risk of being affected by seismicity because of its proximity to active faults and areas of higher potential ground motion. The STS has a negligible risk of fissure formation near the terminus north of Phoenix.

3.3.4.7.3.3 Geologic Strata or Landform Changes

There would be no impacts to geologic strata or landform changes for the exiting transmission systems and communication sites because no changes are planned.

3.3.4.7.4 No Action Impact Summary – All Project Components

For the No Action Alternative, there would be no impacts to unique geologic features because no such features were identified in the course of the analysis.

For the No Action Alternative, there would be no direct impacts to project components from geologic hazards for the NGS and associated facilities, the proposed KMC, and the communication sites. Based on the low seismicity and the absence of identified active source faults, the NGS and associated facilities, the proposed KMC, and the communication sites are not likely to experience damaging earthquake-generated ground motions. The WTS has a minor risk of being affected by seismicity because of its proximity to active faults and areas of higher potential ground motion. The STS has a negligible risk of fissure formation near the terminus north of Phoenix.

Overall, there would be negligible to no impacts to geologic strata and landforms for NGS and the proposed KMC because operations would cease, facilities would be removed, and the sites would be reclaimed. The existing transmission systems and communication sites would remain, but because no changes are proposed, there would be no impacts to geologic strata or landforms at these locations.

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Section 3.4

Mineral Resources

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Acronyms and Abbreviations

1969 Lease	Navajo Project Indenture of Lease
BART	Best Available Retrofit Technology
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BM&LP Railroad	Black Mesa & Lake Powell Railroad
BO	Biological Opinion
CAP	Central Arizona Project
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CO_2	carbon dioxide
Co-tenants	Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
Development Fund	Lower Colorado River Basin Development Fund
EIS	Environmental Impact Statement
ERA	Ecological Risk Assessment
ESA	Endangered Species Act of 1973
HHRA	Human Health Risk Assessment
km	kilometer
KMC	Kayenta Mine Complex
kV	kilovolt
kW	kilowatt
MW	megawatt
N-Aquifer	Navajo Aquifer
NEPA	National Environmental Policy Act of 1969, as amended
NGS	Navajo Generating Station
NGS Participants	U.S. (Reclamation), Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
NHPA	National Historic Preservation Act
NNEPA	Navajo Nation Environmental Protection Agency
NO_2	nitrogen dioxide
NO_X	nitrogen oxide
OSMRE	Office of Surface Mining Reclamation and Enforcement
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 microns or less
PFR	Partial Federal Replacement
PWCC	Peabody Western Coal Company
Reclamation	U.S. Bureau of Reclamation
ROW	Right-of-way

SO_2	sulfur dioxide
SRP	Salt River Project Agricultural Improvement and Power District
STS	Southern Transmission System
U.S.	United States
USEPA	U.S. Environmental Protection Agency
WTS	Western Transmission System

Contents

3.4 Mineral Resources ... 3.4-1
3.4.1 Regulatory Framework ... 3.4-1
3.4.2 Study Areas ... 3.4-1
3.4.2.1 Proposed Action and Action Alternatives ... 3.4-1
3.4.2.2 Cumulative ... 3.4-2
3.4.3 Affected Environment ... 3.4-2
3.4.3.1 Navajo Generating Station ... 3.4-2
3.4.3.2 Proposed Kayenta Mine Complex ... 3.4-2
3.4.3.3 Transmission Systems and Communication Sites ... 3.4-3
3.4.4 Environmental Consequences ... 3.4-4
3.4.4.1 Issues ... 3.4-4
3.4.4.2 Assumptions and Impact Methodology ... 3.4-4
3.4.4.3 Proposed Action ... 3.4-4
3.4.4.4 Natural Gas Partial Federal Replacement Alternative ... 3.4-5
3.4.4.5 Renewable Partial Federal Replacement Alternative ... 3.4-6
3.4.4.6 Tribal Partial Federal Replacement Alternative ... 3.4-7
3.4.4.7 No Action ... 3.4-8
3.4.5 References ... 3.4-9

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3.4 Mineral Resources

3.4.1 Regulatory Framework

A general definition of mineral resources is “a concentration of naturally occurring solid, liquid, or gaseous material in or on the Earth’s crust in such form and amount that economic extraction of a commodity from the concentration is currently or potentially feasible” (U.S. Geological Survey 2016). The following is a list of statutes and rules that apply to mineral extraction:

Surface Mining Control and Reclamation Act of 1977 30 United States Code Subsection 1201 et seq.

- Applies only to surface coal mining.
- The Office of Surface Mining Reclamation and Enforcement is the permitting and enforcement authority.

Mineral Leasing Act of 1920, as amended, 30 United States Code Section 181 et seq. and Federal Coal Leasing Amendments Act of 1976, as amended, 90 Statute 1083-1092 43 Code of Federal Regulations (CFR) 3400:

- Coal Leasing on Federal Lands Exploration License.
- Competitive Lease.
- Lease by Application.

Mining Law of 1872, as amended, 30 United States Code Section 22 et seq. Public Law 167 of 1955, 30 United States Code Section 601 et seq. and Federal Land Policy and Management Act of 1976, 43 United States Code Section 1701 et seq. 43 CFR 3715 and 43 CFR 3802, 3809.

- Governs locatable minerals.

Materials Act of 1947, 30 United States Code Section 601, as amended Public Law 167 of 1955, 30 United States Code Section 601 et seq. and Federal Land Policy and Management Act of 1976, 43 United States Code Section 1701 et seq. 36 CFR 228 Subpart C:

- Mineral Material Contracts Prospecting Permits.
- Free Use Permits.
- Nonexclusive Sales.
- Sale Contracts for Mineral Materials.

Tribal Rules and Regulations

- Navajo Nation; applicable rules of the Navajo Nation Environmental Protection Agency and Division of Natural Resources.
- Hopi Tribe Department of Natural Resources; applicable plans, policies, and ordinances.

3.4.2 Study Areas

3.4.2.1 Proposed Action and Action Alternatives

The study area for mineral resources includes the Navajo Generating Station (NGS) and associated facilities and the proposed Kayenta Mine Complex (KMC). Associated facilities of the NGS include the Black Mesa & Lake Powell (BM&LP) Railroad right-of-way (ROW) that extends from the proposed KMC to the NGS, the coal combustion residuals disposal site, lake pumping station, water pipeline, a 230-kilovolt electrical transmission line, powerlines from the pump station to the NGS, the road between Navajo Nation Route 22B and the pump station, and the coal loadout facility (**Table 1-2, Figure 1-3**). In addition, the study area extends along the maintained ROWs for the transmission systems and communication sites.

3.4.2.2 Cumulative

The cumulative effects study area is the same as the Proposed Action study area because cumulative effects on mineral resources due to the action alternatives are not likely to occur beyond the Proposed Action study area boundary.

3.4.3 Affected Environment

Coal is the primary mineral of interest in the NGS and associated facilities and proposed KMC. There are no commercial oil and gas resources in most of the study area. The Colorado Plateau has been host to exploration and mining of uranium minerals. Uranium mining has occurred in areas on or adjacent to some project facilities. With the exception of one copper mine, precious and base metals are not anticipated mineral resources where project facilities are located.

3.4.3.1 Navajo Generating Station

There are no documented mineral deposits at the NGS site and associated facilities. The Cretaceous coal-bearing units at Black Mesa are not present in the NGS and associated facilities areas, and there are no other coal bearing units. The Kaibito Plateau area is noticeably barren of other mineral resources, including oil and gas, and industrial minerals (Peirce 1987; Rauzi 2015). There also is a low potential for geothermal resources (Conley and Giardina 1979). Precious and base metal occurrences are rare and no mining currently occurs in the area. However, 10 miles south of Page, Arizona, there is a copper occurrence where copper ore was mined intermittently from the 1880s until 1968 (Coppermine Chapter 2015; Yurth 2013). The copper mineralization consists of mainly low-grade malachite, with occasional pockets of higher-grade ore (Read et al. 1943).

The bedrock formations in the study area contain uranium mineralization and former uranium mining sites are present in the northern Arizona area (U.S. Environmental Protection Agency 2015). Uranium was produced at a site a few miles to the southeast of the NGS facility. According the U.S. Environmental Protection Agency (2015), there are many former uranium “production” sites in the northern Arizona range consisting of shallow trenches to pits over 100 feet deep.

3.4.3.2 Proposed Kayenta Mine Complex

The primary mineral resource on the Black Mesa is coal. An early mine was identified by Campbell and Gregory (1909) at Keams Canyon at the southern end of the Black Mesa. This mine produced 2,500 tons of coal in 1908 for local use. Modern mining began in 1970 with the opening of the Black Mesa Mine, which produced 149.6 million tons of coal through 2005 (U.S. Energy Information Agency, 2016; Peabody Western Coal Company [PWCC] 2012 et seq.). The Kayenta Mine opened in 1973 and has produced 305 million tons of coal through 2014. Of the leased reserves of 670 million tons of coal, approximately 455 million tons have been mined through 2014. An additional 100 million tons of coal reserves are available within the lease area should additional tons be needed to be leased in the future (PWCC 2012 et seq.).

No other important mineral resources have been documented on the Black Mesa. Oil and gas test wells have been drilled sporadically, but no commercial resources have been found (Arizona Oil and Gas Conservation Commission 2015). The potential for hydrocarbon production from the Mancos Shale at Black Mesa is unknown because there are no geochemical analyses for total organic carbon content or wells drilled to specifically test the shale (Rauzi 2015; Rauzi and Spencer 2013).Although coalbed natural gas from Cretaceous coal–bearing rocks is a potential resource at Black Mesa, no coalbed natural gas production has been reported (Rauzi 2015). The Wepo and Toreva formations may not be commercially viable for coalbed natural gas due to extensive erosion and canyon cutting resulting in de-gassing of the coals. The Dakota Formation coals may have potential, but have not been tested (Stevens et al. 2002; U.S. Environmental Protection Agency 2013). Minor amounts of scoria, also called clinker, are formed when rocks adjacent to burning coal seams are baked and subjected to thermal metamorphism. The scoria is quarried for road maintenance aggregate and placement in portions of the mined and reclaimed areas to promote medicinal and traditional plant growth (Office of Surface Mining Reclamation and Enforcement 2011).

3.4.3.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

The mineral resources in the regions crossed by the transmission system corridors and where the communication sites are located consist mainly of industrial minerals including stone, clay, gypsum, limestone, and aggregate (Peirce 1987). Uranium occurrences and production sites are present within and adjacent to the corridors. Oil and gas resources largely are absent.

3.4.3.3.1 Western Transmission System

In the Arizona and Utah portions of the Western (NGS to the McCullough) Transmission System corridor, there are a variety of mineral resources including oil and gas, uranium, base and precious metals, rare earth metals, gypsum, building stone, and aggregate (Bureau of Land Management [BLM] 2007). A few uranium occurrences and prospects appear to be adjacent or near the corridor. In Arizona, portions of the transmission route cross areas that have been withdrawn from mineral entry under the Mining Law of 1872 (BLM 2012). The withdrawal would affect locatable minerals such as uranium and precious and base metals, but would not affect leasable minerals and saleable minerals. In Nevada, mineral resources mainly consist of gypsum, limestone, and aggregate (BLM 2015). There are no coal or oil and gas resources in the Nevada portion of the Western Transmission System.

3.4.3.3.2 Southern Transmission System

There are few mineral resources where the corridor crosses the Kaibito Plateau area as discussed above for NGS and ancillary facilities. About 30 miles south of Page, Arizona, the corridor crosses the Cameron uranium mining area that follows the corridor. The Cameron uranium mining area stretches along U.S. Highway 89 for about 18.0 miles and is about 5.0 miles wide (Chenoweth 1993). The uranium ore was mined from members of the Chinle, Kayenta, and Moenkopi formations. Mining occurred in the area from 1951 to 1963, mostly from excavations and pits. However, some underground mining was conducted and 289,247 tons of ore was mined, which produced 1.2 million pounds of uranium oxide.

South of the Cameron uranium area to Phoenix, the mineral commodities consist of industrial minerals (stone, clay, gypsum) and precious and base metals (Peirce 1987).

3.4.3.3.3 Communication Sites

The mineral resources for the communication sites are generally the same as for the transmission system or facility to which they are associated.

3.4.4 Environmental Consequences

3.4.4.1 Issues

The purpose of the mineral resources section is to assess what impacts would occur to mineral resources as a result of the Proposed Action and alternatives. The specific threshold for impacts is the potential preclusion of access to mineral resources from each of the project components as described in Section 3.4.3. Mineral deposits by their nature are often hidden from immediate detection and it is possible that undiscovered mineral deposits may intersect or lie beneath project facilities. Another potential impact that is specific to the proposed KMC and is whether there are adequate coal resources to provide fuel to NGS.

Issue 1 – Access to Minerals

- Potential for facilities or operations associated with the NGS-KMC to preclude development of other mineral resources.

Issue 2 – Adequacy of Coal Resources

- Adequate coal availability at the proposed KMC for NGS consumption through 2044.

3.4.4.2 Assumptions and Impact Methodology

It was assumed that no field surveys would be conducted to collect data and that data would be acquired from readily available published or government agency sources, academic institutions, or information provided by the NGS Participants and PWCC (Section 3.4.5, References). It also was assumed that the sources used provided reasonable estimates regarding the occurrence and development potential of mineral resources that may be present in proximity to the project components. An exhaustive review of mineral claims or leases was not conducted in the preparation for this analysis and such a review would be outside the scope of the analysis. The description of mineral resources was used to analyze potential impacts.

The methodology for analysis of potential impacts was to review the available data and make a determination whether there is a potential that actions would result in a loss of availability of mineral resources. With regard to the proposed KMC, the stated coal reserves at the mine were compared to potential NGS future consumption.

3.4.4.3 Proposed Action

3.4.4.3.1 Navajo Generating Station

3.4.4.3.1.1 Access to Minerals

There is a low probability that commercially extractable minerals are present in the vicinity of the NGS and associated facilities, including the BM&LP Railroad ROW. Therefore, the Proposed Action for either the 3-Unit Operation or 2-Unit Operation would have negligible impacts on access to minerals.

3.4.4.3.2 Proposed Kayenta Mine Complex

3.4.4.3.2.1 Access to Minerals

There is a low probability that commercially extractable minerals other than coal are present in the vicinity of the proposed KMC. Therefore, impacts due to restriction of access to minerals are negligible.

3.4.4.3.2.2 Adequacy of Coal Resources

The PWCC life-of-mine plan anticipates that there will be adequate coal to meet NGS generation requirements from 2020 through 2044 (Section 2.3.1.2, **Table 2-6**). Coal would be mined from existing and new coal resource areas over this period at the rate of 8.1 million tons per year to support a NGS 3-Unit Operation, or 5.5 million tons per year to support a NGS 2-Unit Operation. There would be no impacts as a result of inadequate coal resources.

3.4.4.3.3 Transmission Systems and Communication Sites

3.4.4.3.3.1 Access to Minerals

There is a low probability that commercially extractable minerals are present within the transmission system corridors and communication sites. Therefore, the Proposed Action for either the 3-Unit Operation or 2-Unit Operation would have negligible impacts on access to minerals.

3.4.4.3.4 Project Impact Summary – All Project Components

Under the Proposed Action, impacts to mineral resource availability from each of the project components are expected to be negligible because of the low probability of commercially extractable minerals in the study area except for coal.

Coal resources at the proposed KMC would be adequate to meet NGS power generation commitments and there would be no impacts from inadequate coal to meet the demands for power generation under the Proposed Action.

3.4.4.3.5 Cumulative Impacts

No reasonably foreseeable actions are expected to occur that would intersect with the study area for minerals defined in Section 3.4.2; as a result, no cumulative impacts would occur.

3.4.4.4 Natural Gas Partial Federal Replacement Alternative

Under the Natural Gas Partial Federal Replacement (PFR) Alternative, a selected quantity of power between 100 megawatts (MW) and 250 MW would be contracted for under a long-term power purchase agreement from currently unidentified, existing natural gas generation sources, displacing an equivalent amount of power from the federal share of NGS generation. Because the facility is assumed to currently exist, prior impacts to mineral resources are not evaluated. The following are key assumptions about resources related to such an existing site:

- Because the site is not known, no site specific evaluation for the presence of mineral resources was performed.
- The site does not present a hindrance to mineral entry.
- Valuable mineral resources are not present.

Impact issues for the Natural Gas PFR Alternative are discussed across the range of NGS unit operations (3-Unit and 2-Unit) and associated alternative power reductions (100 MW and 250 MW) from the least NGS power reduction to the greatest. Reductions in NGS power generation would proportionally reduce the quantity of coal delivered from the Kayenta Mine.

The focus of this discussion is to distinguish differences in impacts within the replacement alternative operational range to provide a basis for comparison with the Proposed Action.

3.4.4.4.1 Navajo Generating Station

3.4.4.4.1.1 Access to Minerals

As with the Proposed Action Alternative, there is a low probability that commercially extractable minerals are present in the vicinity of the NGS and associated facilities, including the BM&LP Railroad ROW. Therefore, the Natural Gas PFR Alternative would have negligible impacts on access to minerals.

3.4.4.4.2 Proposed Kayenta Mine Complex

3.4.4.4.2.1 Access to Minerals

As with the Proposed Action Alternative, there is a low probability that commercially extractable minerals other than coal are present in the vicinity of the proposed KMC. Therefore, impacts due to restriction of access to mineral are negligible.

3.4.4.4.2.2 Adequacy of Coal Resources

Under the Natural Gas PFR Alternative, there would be sufficient coal resources to provide fuel to the plant from 2020 to 2044. Consumption would be less than the coal consumption under the Proposed Action where it is expected that coal resources are adequate to support generation under the 3-Unit Operation or 2-Unit Operation. The Natural Gas PFR Alternative is the lowest coal consuming alternative and the lowest with respect to the 100-MW and 250-MW cases.

3.4.4.4.3 Transmission Systems and Communication Sites

3.4.4.4.3.1 Access to Minerals

There is a low probability that commercially extractable minerals are present within the transmission system corridors and communication sites. Therefore, like the Proposed Action, the Natural Gas PFR Alternative for either the 3-Unit Operation or 2-Unit Operation would have negligible impacts on access to minerals.

3.4.4.4.4 Project Impact Summary – All Project Components

Under the Natural Gas PFR Alternative, impacts to mineral resource availability from each of the project components are expected to be negligible because of the low probability of commercially extractable minerals in the study area except for coal.

Under the Natural Gas PFR Alternative coal resources at the proposed KMC would be adequate to meet NGS power generation commitments and there would be no impacts from inadequate coal to meet the demands for power generation. Consumption would be less than the coal consumption under the Proposed Action and the Natural Gas PFR Alternative represents the lowest coal consuming alternative.

3.4.4.4.5 Cumulative Impacts

No reasonably foreseeable actions are expected to occur that would intersect with the study area for minerals defined in Section 3.4.2; as a result, no cumulative impacts would occur.

3.4.4.5 Renewable Partial Federal Replacement Alternative

Under the Renewable PFR Alternative, a selected quantity of power between 100 MW and 250 MW would be contracted for under a long-term power purchase agreement from a currently unidentified, existing renewable energy power source, displacing an equivalent amount of power from the federal share of NGS generation. Because the facility is assumed to currently exist, prior impacts to mineral resources are not evaluated. The following are key assumptions about resources related to such an existing site:

- Because the site is not known, no site specific evaluation for the presence of mineral resources was performed.
- The site does not present a hindrance to mineral entry.
- Valuable mineral resources are not present.

Impact issues for the Renewable PFR Alternative are discussed across the range of NGS unit operations (3-Unit and 2-Unit) and associated alternative power reductions (100 MW and 250 MW) from the least

NGS power reduction to the greatest. Reductions in NGS power generation would proportionally reduce the quantity of coal delivered from the Kayenta Mine.

The focus of this discussion is to distinguish differences in impacts within the replacement alternative operational range to provide a basis for comparison with the Proposed Action.

3.4.4.5.1 Navajo Generating Station

3.4.4.5.1.1 Access to Minerals

As with the Proposed Action Alternative, there is a low probability that commercially extractable minerals are present in the vicinity of the NGS and associated facilities, including the BM&LP Railroad ROW. Therefore, the Renewable PFR Alternative would have negligible impacts on access to minerals.

3.4.4.5.2 Proposed Kayenta Mine Complex

3.4.4.5.2.1 Access to Minerals

Under the Renewable PFR Alternative there is a low probability that commercially extractable minerals other than coal are present in the vicinity of the proposed KMC. Therefore, impacts due to restriction of access to mineral are negligible.

3.4.4.5.2.2 Adequacy of Coal Resources

Under the Renewable PFR Alternative, there would be sufficient coal resources to provide fuel to the plant from 2020 to 2044 since consumption would still be less than the coal consumption under the Proposed Action where it is expected that coal resources are adequate to support generation under the 3-Unit Operation or 2-Unit Operation.

3.4.4.5.3 Transmission Systems and Communication Sites

3.4.4.5.3.1 Access to Minerals

There is a low probability that commercially extractable minerals are present within the transmission system corridors and communication sites. Therefore, like the Proposed Action, the Renewable PFR Alternative for either the 3-Unit Operation or 2-Unit Operation would have negligible impacts on access to minerals.

3.4.4.5.4 Project Impact Summary – All Project Components

Under the Renewable PFR Alternative, impacts to mineral resource availability from each of the project components are expected to be negligible because of the low probability of commercially extractable minerals in the study area except for coal.

Under the Renewable PFR Alternative coal resources at the proposed KMC would be adequate to meet NGS power generation commitments and there would be no impacts from inadequate coal to meet the demands for power generation.

3.4.4.5.5 Cumulative Impacts

No reasonably foreseeable actions are expected to occur that would intersect with the study area for minerals defined in Section 3.4.2; as a result, no cumulative impacts would occur.

3.4.4.6 Tribal Partial Federal Replacement Alternative

Under the Tribal PFR Alternative, between 100 MW and 250 MW of power generation from the NGS would be replaced by power supplied by a new photovoltaic generation facility on tribal land, displacing an equivalent amount of power from the federal share of NGS generation. The construction of a new photovoltaic generation site on tribal land would result in between 1,200 and 3,000 acres of new surface disturbance. The Tribal PFR facility would be analyzed in a separate National Environmental Policy Act process once a facility location is identified.

3.4.4.6.1 Navajo Generating Station

3.4.4.6.1.1 Access to Minerals

As with the Proposed Action Alternative, there is a low probability that commercially extractable minerals are present in the vicinity of the NGS and associated facilities, including the BM&LP Railroad ROW. Therefore, the Tribal Gas PFR Alternative would have negligible impacts on access to minerals.

3.4.4.6.2 Proposed Kayenta Mine Complex

3.4.4.6.2.1 Access to Minerals

Under the Tribal PFR Alternative there is a low probability that commercially extractable minerals other than coal are present in the vicinity of the proposed KMC. Therefore, impacts due to restriction of access to mineral are negligible.

3.4.4.6.2.2 Adequacy of Coal Resources

Under the Tribal PFR Alternative, there would be sufficient coal resources to provide fuel to the plant from 2020 to 2044 since consumption would still be less than the coal consumption under the Proposed Action where it is expected that coal resources are adequate to support generation under the 3-Unit Operation or 2-Unit Operation.

3.4.4.6.3 Transmission Systems and Communication Sites

3.4.4.6.3.1 Access to Minerals

There is a low probability that commercially extractable minerals are present within the transmission system corridors and communication sites. Therefore, like the Proposed Action, the Tribal PFR Alternative for either the 3-Unit Operation or 2-Unit Operation would have negligible impacts on access to minerals.

3.4.4.6.4 Project Impact Summary – All Project Components

Under the Tribal PFR Alternative, impacts to mineral resource availability from each of the project components are expected to be negligible because of the low probability of commercially extractable minerals in the study area except for coal.

Under the Tribal PFR Alternative coal resources at the proposed KMC would be adequate to meet NGS power generation commitments and there would be no impacts from inadequate coal to meet the demands for power generation.

3.4.4.6.5 Cumulative Impacts

No reasonably foreseeable actions are expected to occur that would intersect with the study area for minerals defined in Section 3.4.2; as a result, no cumulative impacts would occur.

3.4.4.7 No Action

3.4.4.7.1 Navajo Generating Station

3.4.4.7.1.1 Access to Minerals

There is a low probability that commercially extractable minerals are present in the vicinity of the NGS and associated facilities. Therefore, the No Action Alternative would have negligible impacts on access to minerals. Any impacts to access to other mineral resources would be further reduced by the closure and reclamation of the NGS and associated facilities. Thus, if other minerals are found to be commercially extractable, there would be no barrier to development after reclamation of the site.

3.4.4.7.2 Proposed Kayenta Mine Complex

3.4.4.7.2.1 Access to Minerals

Under the No Action Alternative there is a low probability that commercially extractable minerals other than coal are present in the vicinity of the proposed KMC. Therefore, impacts due to restriction of access to mineral are negligible. Any impacts to access to other mineral resources would be further reduced by the closure and reclamation of the proposed KMC. Thus, if other minerals are found to be commercially extractable, there would be no barrier to development after reclamation of the site.

3.4.4.7.2.2 Adequacy of Coal Resources

Under the No Action Alternative, no mining would occur after 2019 and 5,230 to 4,741 acres of coal would not be extracted, unless other markets could be found for the coal and a separate authorization was provided by Office of Surface Mining Reclamation and Enforcement. Adequacy of coal reserves to fuel the NGS would not be a concern and leasing of additional coal areas would not occur.

3.4.4.7.3 Transmission Systems and Communication Sites

3.4.4.7.3.1 Access to Minerals

There is a low probability that commercially extractable minerals are present within the transmission line ROWs and communication sites. Therefore, it is likely that the No Action Alternative would have negligible impacts on access to minerals.

3.4.4.7.4 No Action Impact Summary – All Project Components

The No Action would have negligible impact concerning the availability of mineral resources at NGS and associated facilities, proposed KMC, and the transmission systems and communication sites. Any impacts to access to other mineral resources would be further reduced by the closure and reclamation of the NGS and associated facilities and the proposed KMC. Thus, if other minerals are found to be commercially extractable, there would be no barrier to development after reclamation of these sites.

Under the No Action Alternative, adequacy of coal reserves to fuel the NGS would not be a concern and leasing of additional coal areas would not occur.

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Section 3.5

Paleontological Resources

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1 # Acronyms and Abbreviations

1969 Lease	Navajo Project Indenture of Lease
BART	Best Available Retrofit Technology
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BM&LP Railroad	Black Mesa & Lake Powell Railroad
BO	Biological Opinion
CAP	Central Arizona Project
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CO_2	Carbon dioxide
Co-tenants	Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
Development Fund	Lower Colorado River Basin Development Fund
EIS	Environmental Impact Statement
ERA	Ecological Risk Assessment
ESA	Endangered Species Act of 1973
HHRA	human health risk assessment
km	kilometer
KMC	Kayenta Mine Complex
kV	kilovolt
kW	kilowatt
MW	megawatt
N-Aquifer	Navajo Aquifer
NEPA	National Environmental Policy Act of 1969, as amended
NGS	Navajo Generating Station
NGS Participants	U.S. (Reclamation), Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
NHPA	National Historic Preservation Act
NNEPA	Navajo Nation Environmental Protection Agency
NO_2	Nitrogen dioxide
NO_X	Nitrogen oxide
OSMRE	Office of Surface Mining Reclamation and Enforcement
PM	Particulate matter
PM_{10}	Particulate matter with an aerodynamic diameter of 10 microns or less
$PM_{2.5}$	Particulate matter with an aerodynamic diameter of 2.5 microns or less
PFR	Partial Federal Replacement
PWCC	Peabody Western Coal Company
Reclamation	Bureau of Reclamation
ROW	Right-of-way

SO_2	Sulfur dioxide
SRP	Salt River Project Agricultural Improvement and Power District
STS	Southern Transmission System
U.S.	United States
USEPA	U.S. Environmental Protection Agency
WTS	Western Transmission System

Contents

3.5 Paleontological Resources 3.5-1
3.5.1 Regulatory Framework 3.5-1
3.5.2 Study Areas 3.5-1
3.5.2.1 Proposed Action and Action Alternatives 3.5-1
3.5.2.2 Cumulative 3.5-1
3.5.3 Affected Environment 3.5-1
3.5.3.1 Navajo Generating Station 3.5-2
3.5.3.2 Proposed Kayenta Mine Complex 3.5-3
3.5.3.3 Transmission Lines and Communication Sites 3.5-3
3.5.4 Environmental Consequences 3.5-5
3.5.4.1 Issues 3.5-5
3.5.4.2 Assumptions and Impact Methodology 3.5-6
3.5.4.3 Proposed Action 3.5-6
3.5.4.4 Natural Gas Partial Federal Replacement Alternative 3.5-9
3.5.4.5 Renewable Partial Federal Replacement Alternative 3.5-11
3.5.4.6 Tribal Partial Federal Replacement Alternative 3.5-12
3.5.4.7 No Action 3.5-14
3.5.5 References 3.5-16

List of Tables

Table 3.5-1 Potential Fossil Yield Classification Rating NGS and Proposed KMC 3.5-2
Table 3.5-2 Potential Fossil Yield Classification Rating Western Transmission System 3.5-3
Table 3.5-3 Potential Fossil Yield Classification Rating Southern Transmission System 3.5-4
Table 3.5-4 Potential Fossil Yield Classification Ratings for Communication Sites 3.5-4

3.5 Paleontological Resources

3.5.1 Regulatory Framework

The primary statute for the protection of fossils is the Paleontological Resources Preservation Act of 2009, which empowered various federal land management agencies to generate regulations for the protection of fossil resources. The Paleontological Resources Protection Act of 2009, however, does not apply to tribal lands. In order to collect "embedded fossils," or fossils embedded in the rock, a permit is needed from the Bureau of Indian Affairs (BIA) (BIA 2012). Collecting non-embedded fossils does not require a permit from the BIA; however, collecting activities are under the jurisdiction of tribal authorities.

The U.S. Forest Service and the Bureau of Land Management (BLM) also have established regulations and guidance regarding the preservation and collection of fossil resources. The agencies developed a system whereby geologic units can be ranked according to fossil potential as the first step in resource management and protection.

3.5.2 Study Areas

3.5.2.1 Proposed Action and Action Alternatives

The study area for paleontological resources includes the Navajo Generating Station (NGS) and associated facilities, and the proposed Kayenta Mine Complex (KMC) (**Figure 3.3-1**). Associated facilities of the NGS include the Black Mesa & Lake Powell Railroad right-of-way that extends from the proposed KMC to the NGS, the coal combustion residuals disposal site, lake pumping station, water pipeline, a 230-kilovolt electrical transmission line, powerlines from the pump station to the NGS, the road between Navajo Nation Route 22B and the pump station, and the coal loadout silo. (**Table 1-2, Figure 1-3**). In addition, the study area extends along the maintained transmission system corridor right-of-way and communication sites.

3.5.2.2 Cumulative

The cumulative effects study area is the same as the Proposed Action study area since direct and indirect effects on paleontological resources due to the Proposed Action and alternatives are not likely to occur beyond the Proposed Action boundary.

3.5.3 Affected Environment

The Potential Fossil Yield Classification system provides a way to rank geologic units based on the relative abundance of scientifically important fossils (plants, vertebrates, and invertebrates). A higher rank number (listed below) indicates a higher potential for the occurrence of fossils of scientific importance. The Potential Fossil Yield Classification system is not intended to be applied to specific paleontological localities or small areas within units. Although important localities may occasionally occur in a geologic unit, a few widely scattered important fossils or localities do not necessarily indicate a higher class; instead, the relative abundance of significant localities is intended to be the major determinant for the class assignment. The classification should be used to assist in determining the need for further management, including mitigation, assessment, or other actions. Descriptions of the potential fossil yield classes are summarized below (BLM 2013):

- Class 1—Igneous and metamorphic geologic units (excluding tuffs) that are not likely to contain recognizable fossil remains.
- Class 2—Sedimentary geologic units that are not likely to contain vertebrate fossils or scientifically important nonvertebrate fossils.

- Class 3—Fossiliferous sedimentary geologic units where fossil content varies in significance, abundance, and predictable occurrence (3a); or unknown potential (3b), but could contain fossils based on geologic features or apparent preservation condition.
- Class 4— Geologic units containing a high occurrence of scientifically important fossils. Proposed ground-disturbing activities would require assessment to determine whether significant paleontological resources occur in an area of proposed disturbance.
- Class 5—Highly fossiliferous geologic units that regularly and predictably produce vertebrate fossils or scientifically important nonvertebrate fossils and that are at high risk of natural degradation or human-caused adverse impacts.

The Potential Fossil Yield Classification is used by the BLM and the U.S. Forest Service for management of fossil resources on lands managed by the respective agencies. The use of the Potential Fossil Yield Classification system here is to provide guidance for assessing paleontological resources regardless of surface ownership or managing agency.

The bedrock in the study area contains formations with high potential for scientifically important fossils. There are numerous sedimentary rock units that have a documented abundance of scientifically important fossils. The discussions in the following sections are intended to be brief summaries of fossil potential and highlights of known fossils in the study area and are not intended to be exhaustive. The Potential Fossil Yield Classification system is used herein because it provides the most effective way to convey the potential for formations to contain fossils and thereby what management measures may be necessary for protection of the resource.

3.5.3.1 Navajo Generating Station

Table 3.5-1 lists the formations that are within the footprint of the NGS and associated facilities and proposed KMC and their Potential Fossil Yield Classification system rankings. The fossil potential of these formations varies greatly from unit to unit. Some formations, like the Morrison Formation, have yielded diverse fauna including vertebrates and invertebrates (Foster et al. 2001). Fossils are rare in the Navajo Sandstone, but track sites have been found in Southern Utah in the Kaiparowits Plateau region.

Table 3.5-1 Potential Fossil Yield Classification Rating NGS and Proposed KMC

Formation/Unit	Age	Potential Fossil Yield Classification Rank
Mesaverde Group	Upper Cretaceous	3
Mancos Shale	Upper Cretaceous	3-5
Dakota Formation	Upper Cretaceous	3-5
Morrison Formation	Upper Jurassic	4-5
Cow Springs Sandstones	Middle Jurassic	ND
Entrada Sandstone	Middle Jurassic	2-3
Carmel Formation	Middle Jurassic	2-3
Page Sandstone	Middle Jurassic	2-3a
Navajo Sandstone	Lower Jurassic	2-3

Source: BLM 2007; Foster et al. 2001; Reppening and Page 1956; U.S. Department of Energy and U.S. Department of the Interior 2008.

ND = Not Determined.

Most of the geologic formations in the study area have low to medium potential, but the Morrison is a high-potential formation that has yielded dinosaur fossils over the entire region. While the Dakota has somewhat medium potential in the analysis area, it has a high potential regionally. The Mancos also is a high-potential formation regionally.

The NGS and associated facilities are underlain by the Navajo Sandstone, Page Sandstone, and Carmel Formation which have low to medium fossil potential as shown in **Table 3.5-1**.

3.5.3.2 Proposed Kayenta Mine Complex

The proposed KMC is primarily underlain by the Cretaceous coal-bearing Wepo Formation of the Mesaverde Group as shown in **Figure 3.3-3**. The coal conveyor located northwest of the coal lease boundary crosses other formations that include the Mancos Shale, Dakota Formation, The San Rafael Group, and the Glen Canyon Group. As shown in **Table 3.5-1**, some of these formations have medium to high potential to contain valuable fossils.

3.5.3.3 Transmission Lines and Communication Sites

The transmission line corridors and communication sites cover a large area with large diversity of geologic units and fossil potential. The descriptions that follow are intended to briefly summarize fossil bearing formations and are not intended to be an exhaustive discussion.

3.5.3.3.1 Western Transmission System

The Western (NGS to McCullough) Transmission System (WTS) (as described in detail in Chapter 1.0) crosses alluvium and unconsolidated valley fill deposits and Paleozoic, Triassic, and Tertiary sedimentary rocks (**Table 3.5-2**) (Arizona Geological Survey 2015; Longwell et al. 1965; Stewart and Carlson 1978). The formations and deposits crossed by the Western Transmission Corridor have low to medium fossil potential.

Table 3.5-2 Potential Fossil Yield Classification Rating Western Transmission System

Formation/Unit	Age	Potential Fossil Yield Classification Rank
Alluvium and unconsolidated materials	Quaternary	2
Horse Spring	Late Eocene to Late Miocene	3
San Rafael Group	Middle to Late Jurassic	2-3
Glen Canyon Group	Early to Middle Jurassic	2-3
Chinle Formation	Upper Triassic	3
Moenkopi	Lower Triassic	3
Kaibab, Toroweep, Coconino	Permian	3
Supai Formation	Pennsylvanian to Permian	2
Bird Spring	Mississippian to Early Permian	2
Monte Cristo	Mississippian	2
Limestone	Late Cambrian to Middle Cambrian	2
Precambrian	Early Proterozoic	1

Source: Arizona Geological Survey 2015; BLM and U.S. Forest Service 2013; U.S. Department of Energy and U.S. Department of the Interior 2008; U.S. Department of Energy and U.S. Department of the Interior 2013.

3.5.3.3.2 Southern Transmission System

Table 3.5-3 lists the geological units that are crossed by the Southern (NGS to Westwing) Transmission System (STS) (as described in detail in Chapter 1.0). The fossil potential classification ranges from low to medium.

Table 3.5-3 Potential Fossil Yield Classification Rating Southern Transmission System

Formation/Unit	Age	Potential Fossil Yield Classification Rank
Unconsolidated	Holocene	1
Unconsolidated surficial deposits	Middle to Late Pleistocene	1
Unconsolidated surficial deposits	Late Pliocene to Early Pleistocene	1
Volcanic rocks	Tertiary, Quaternary, Holocene	1
Older Tertiary sedimentary deposits.	Paleocence to Pliocene	1
San Rafael Group	Middle to Late Jurassic	2-3
Glen Canyon Group	Early Jurassic	2-3
Chinle	Late Triassic	3
Moenkopi Formation	Early and Middle Triassic	3
Kaibab Formation	Permian	3
Redwall Limestone	Mississippian	2
Temple Butte Formation	Middle to Upper Devonian	2
Muav Limestone	Middle Cambrian	2
Bright Angel Shale	Middle Cambrian	2
Tapeats Sandstone	Lower Cambrian	2
Precambrian	Early Proterozoic	1

Source: Arizona Geological Survey 2015; U.S. Department of Energy and U.S. Department of the Interior 2008.

3.5.3.3.3 Communication Sites

Table 3.5-4 list the bedrock formations/geologic units on which the communication sites are located and the Potential Fossil Yield Classification designations. The fossil potential ranges from low to moderate.

Table 3.5-4 Potential Fossil Yield Classification Ratings for Communication Sites

Site Name	Formation/Unit	Age	Potential Fossil Yield Classification Rank
Apex to Crystal	Redwall Limestone and Supai Group	Mississippian to Early Permian	2
Beaver Dam	Redwall	Mississippian	2
Bill Williams	No formation name	Middle Miocene to Pliocene	1
Buckskin Mountain	Toroweap	Early Permian	3
Glen Canyon	Dune sand	Quaternary	1

Table 3.5-4 Potential Fossil Yield Classification Ratings for Communication Sites

Site Name	Formation/Unit	Age	Potential Fossil Yield Classification Rank
Glendale	Muav Limestone	Middle Cambrian to Late Cambrian	2
Jack's Peak	Glen Canyon Group	Early Jurassic	3
Moenkopi	Chinle Formation Shinarump Member	Late Triassic	3
Mount Elden	No formation name	Middle Pliocene to Holocene	1
Mount Francis	Precambrian	Early Proterozoic	1
Navajo	Glen Canyon Group	Early Jurrassic	3
NGS	Glen Canyon Group	Early Jurassic	3
Pipe Springs	Glen Canyon Group	Early Jurassic	3
Preston Mesa	Glen Canyon Group	Early Jurassic	3
Red Mountain	No formation name	Early Miocene to Early Pliocene	1
West Phoenix	Unconsolidated material	Middle to Late Pleistocene	1
Westwing	Unconsolidated material	Middle to Late Pleistocene	1
White Tanks	Precambrian	Early Proterozoic	1
Zilnez Mesa	Glen Canyon Group	Early Jurassic	3

Source: Arizona Geological Survey 2015; U.S. Department of Energy and U.S. Department of the Interior 2008.

3.5.4 Environmental Consequences

3.5.4.1 Issues

Paleontological resources or fossils are the "remains, imprints, or traces of once-living organisms preserved in rocks and sediments. These include mineralized, partially mineralized, or unmineralized bones and teeth, soft tissues, shells, wood, leaf impressions, footprints, burrows, and microscopic remains. Fossils are considered nonrenewable resources because the organisms they represent no longer exist. Thus, once destroyed, a fossil can never be replaced" (Murphey and Daitch 2007). However, some fossils have a greater scientific value than others because of uniqueness or importance in deciphering earth history (dinosaur bones, for example). The destruction of scientifically important fossils, whether deliberate or inadvertent, would be considered a major impact because of the loss of scientific knowledge of the geological history of the earth and the origins and history of life on earth.

The major issue involving paleontological resources is the potential for direct impacts to as yet unidentified valuable paleontological resources. The most likely direct impact to occur would be loss or destruction of scientifically valuable fossils due to ground disturbance. There also are long-term indirect effects that may occur if a fossil locality is known and is exposed to theft and vandalism.

Issue 1 – Destruction of Fossils

- Potential for destruction of scientifically valuable fossils due to ground disturbance.

Issue 2 – Theft and Vandalism

- Potential for theft or vandalism of a known fossil locality.

3.5.4.2 Assumptions and Impact Methodology

It was assumed that no field surveys would be conducted to collect data and that data would be acquired from readily available published or government agency sources or information provided by the NGS Participants and Peabody Western Coal Company. An exhaustive review of sources was not conducted.

The presence of potentially valuable paleontological resources was determined through the use of the Potential Fossil Yield Classification Rating system which relies on identification of geological formations or rock units to provide an estimate of the fossil potential in any given area. A particular unit may have fossil potential that varies widely over geographic areas, so sources and documents were consulted that could provide fossil potential information over the study area. Where possible, the sources that were consulted provided Potential Fossil Yield Classification Rating system designations of the formations within the study area. These sources included BLM and U.S. Forest Service (2013); U.S. Department of Energy and U.S. Department of the Interior (2008); U.S. Department of Energy and U.S. Department of the Interior (2013). Where Potential Fossil Yield Classification Rating classifications were not readily available, other sources were consulted and a Potential Fossil Yield Classification Rating rank was provided based on descriptions of relative fossil abundance. Once the geologic units within the study area were ranked according to fossil yield potential, it was possible to assess the likelihood of potential impacts that may occur. Given a geologic unit with rank of 1, the probability of impacts is greatly reduced, while a ranking of 4 or 5 may warrant protection measures based on the activities that are likely to occur on those high-potential formations. The higher the Potential Fossil Yield Classification Rating rank, the greater probability that a particular geologic unit could contain valuable fossils.

3.5.4.3 Proposed Action

3.5.4.3.1 Navajo Generating Station

3.5.4.3.1.1 Destruction of Fossils

Activities under the Proposed Action would take place primarily on previously disturbed areas at NGS and associated facilities which are not likely to have recoverable paleontological resources. The exception is undisturbed areas that may be within the coal combustion residual disposal facility. Under the 3-Unit Operation scenario, the facility would have to be expanded to handle more coal combustion residual (Salt River Project Agricultural Improvement and Power District 2016). The amount of additional acreage that would be added to the facility is estimated to be 239 acres (Table 3.0-1). However, the possibility remains that the facility would be expanded onto previously undisturbed areas. Also, aerial imagery in conjunction with recent geological mapping shows there are large areas within the facility that exhibit evidence of prior disturbance, but where no coal combustion residuals have been deposited (Billingsley and Priest 2013; Google 2016). The disturbance appears to be water bars or berms that are located on the east side of the facility on a bench topped by the Carmel Formation. Within the disposal area, these are areas that appear to have been graded, but no coal combustion residual has been deposited.

The geologic units that would be affected by potential new disturbance at the coal combustion residual facility are the Navajo and Page Sandstones and the Carmel Formation. These units have Potential Fossil Yield Classification rankings that range from 2 to 3, indicating low to moderate potential for fossils. Given the low to moderate ranking and the probable small amount of actual undisturbed areas within the boundary of the facility, impacts to fossil resources are expected to be negligible. The design of the facility calls for lifts of coal combustion residual that are stacked into drainages or canyons. Although no grading or backfilling would occur on the canyon walls, there is the possibility that fossils could be buried by the lifts that would fill the drainages with coal combustion residual and any fossils would be lost since they would not be readily accessible.

Overall, impacts to paleontological resources are expected to be negligible because of the low to moderate fossil potential of the NGS bedrock formations and limited potential for disturbance of new ground, as ground disturbance is likely to occur in areas that have already been disturbed.

3.5.4.3.1.2 Theft and Vandalism

There would be negligible potential for theft and vandalism of fossil sites because the potential for fossil finds is low to moderate, there are no known fossil localities, and the access to the NGS site would be controlled.

3.5.4.3.1.3 Protection Measures

The following protection measure is recommended for both 3-Unit Operation and 2-Unit Operation.

In the event that activities would result in impacts on fossils not detected previously, work in the area would cease and a qualified professional would evaluate the area. Salt River Project Agricultural Improvement and Power District would work with Reclamation and the BIA for the recovery of important fossils prior to resuming operations. Fossils found on tribal lands are the property of the respective tribes. No other disturbances would be expected to occur outside of previously disturbed areas at the NGS or associated facilities as described in Section 3.5.2.

3.5.4.3.2 Proposed Kayenta Mine Complex

3.5.4.3.2.1 Destruction of Fossils

Ongoing mining activities would have the potential to cause damage or loss of paleontological resources. The Mesaverde Formation has a moderate potential to contain scientifically valuable or important fossils (**Table 3.5-1**). Because fossils are uncommon in the Mesaverde Formation in the Black Mesa area, the potential for destruction of valuable fossils during coal mining is negligible under either the 3-Unit Operation or 2-Unit Operation. The bedrock formations crossed by the coal conveyor to the railroad loadout consist of the Mesaverde Group, Mancos and Dakota formations, the San Rafael Group, and the Glen Canyon Group. The Mancos and Dakota formations have medium to high potential for fossils and the San Rafael and Glen Canyon Groups are medium to low potential. The coal conveyor and associated access road is a previously disturbed area and therefore, impacts to paleontological resources would be negligible.

3.5.4.3.2.2 Theft and Vandalism

In general, there would be negligible potential for theft and vandalism of fossil sites because the potential for fossil finds is moderate within the Mesaverde Formation and there are no known fossil localities.

Where the conveyor crosses the outcrop of the Mancos-Dakota there is a possibility of exposed fossils which could be subject to theft or vandalism. The impacts would be negligible because the access road and conveyor would not be accessible to the public, the terrain limits access, and the outcrops are vegetated and largely covered with colluvium.

3.5.4.3.2.3 Protection Measures

In the event that potentially valuable fossils are encountered during mining or excavation along the coal conveyor, the following measure would be implemented (Office of Surface Mining Reclamation and Enforcement 2011). In the event that mining activities would result in impacts on fossils not detected prior to mining activity, work in the area would cease and a qualified professional would evaluate the area. Peabody Western Coal Company would work with regulatory and tribal officials for the recovery of important fossils prior to resuming mining operations. Peabody Western Coal Company would recover any important fossils discovered during mining operations.

3.5.4.3.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

3.5.4.3.3.1 Destruction of Fossils

Operation and maintenance activities for the transmission systems under the Proposed Action would take place on previously disturbed areas which are not likely to have salvageable paleontological resources. Therefore, no impacts are expected as long as work is confined to the disturbed right-of-way.

Operation and maintenance activities at communication sites under the Proposed Action would take place on previously disturbed areas which are not likely to have salvageable paleontological resources. Therefore, no impacts are expected.

If work were to occur on undisturbed areas, then the protection measures as described below would be implemented.

3.5.4.3.3.2 Theft and Vandalism

There would be no potential for theft and vandalism of fossil sites since the areas have already been disturbed and no significant fossil locations have been identified.

3.5.4.3.3.3 Protection Measures

If occasional activities take place outside of previously disturbed areas, then prior to conducting work, the Potential Fossil Yield Classification rating of the bedrock in the area should be determined and appropriate protection measures should be implemented if necessary. Such measures could include review and survey by a qualified paleontologist. In the event that operation and maintenance activities would result in impacts on fossils not detected prior, activities would cease and a qualified professional would evaluate the area. The operator would work with the appropriate regulatory officials for the recovery of important fossils prior to resuming operations.

3.5.4.3.4 Project Impact Summary – All Project Components

Impacts to fossil resources for all of the project components would be negligible to none because of the generally low to moderate Potential Fossil Yield Classification rank of the bedrock formations. For the NGS and associated facilities, transmission systems and communication sites most activities would occur in previously disturbed areas with no known fossil locations. The recommended protection measures would provide for the proper documentation and recovery of unanticipated discovery of fossil resources.

The potential for theft and vandalism is negligible to none because of the lack of identified significant fossil locations for any of the project components. In addition, for the NGS and proposed KMC, access would be controlled for most areas limiting the potential for theft and vandalism.

3.5.4.3.4.1 Protection Measures

If occasional activities take place outside of previously disturbed areas, then prior to conducting work, the Potential Fossil Yield Classification rating of the bedrock in the area should be determined and appropriate protection measures should be implemented if necessary. Such measures could include review and survey by a qualified paleontologist. In the event that operation and maintenance activities would result in impacts on fossils not detected prior, activities would cease and a qualified professional would evaluate the area. The operator would work with the appropriate regulatory and tribal officials for the recovery of important fossils prior to resuming operations.

3.5.4.3.5 Cumulative Impacts

No reasonably foreseeable actions are expected to occur that would intersect with the cumulative effects study area for paleontological resources as defined in Section 3.5.2. Since impacts to paleontological resources are expected to be negligible to none under the Proposed Action, no cumulative impacts are expected to occur. Since the transmission lines would continue to operate as presently configured, there would be no new disturbance that would impact fossil resources.

3.5.4.4 Natural Gas Partial Federal Replacement Alternative

Under the Natural Gas Partial Federal Replacement (PFR) Alternative, a selected quantity of power between 100 megawatts (MW) and 250 MW would be contracted for under a long-term power purchase agreement from currently unidentified, existing natural gas generation sources, displacing an equivalent amount of power from the federal share of NGS generation. Because the facility is assumed to currently exist, prior disturbance impacts to paleontological resources are not evaluated. The following is a key assumption about paleontological resources related to such an existing site.

- Loss of paleontological resources may have already occurred due to prior ground disturbance.

Impact issues for this PFR Alternative are discussed across the range of NGS unit operations (3-Unit and 2-Unit) and associated alternative power reductions (100 MW and 250 MW) from the least NGS power reduction to the greatest. Reductions in NGS power generation would proportionally reduce the quantity of coal delivered from the Kayenta Mine.

The focus of this discussion is to distinguish differences in impacts within the replacement alternative operational range to provide a basis for comparison with the Proposed Action.

3.5.4.4.1 Navajo Generating Station

3.5.4.4.1.1 Destruction of Fossils

Impacts to fossil resources would be negligible under the Natural Gas PFR Alternative because of the low to moderate fossil potential of the bedrock formations and limited potential for disturbance of new ground, as ground disturbance is likely to occur in areas that have already been disturbed.

3.5.4.4.1.2 Theft and Vandalism

Indirect effects from theft or vandalism are expected to be negligible because there is a low to medium potential for the occurrence of fossils in areas outside of currently disturbed areas, there are no known fossil localities, and the access to the NGS site would be controlled.

3.5.4.4.1.3 Protection Measures

The protection measures for the NGS under the Natural Gas PFR Alternative would be the same as for the Proposed Action.

3.5.4.4.2 Proposed Kayenta Mine Complex

3.5.4.4.2.1 Destruction of Fossils

Impacts would be negligible since important fossils are not expected in the Mesaverde that is mined. The coal conveyor and associated access road is a previously disturbed area and therefore impacts to paleontological resources would be negligible.

3.5.4.4.2.2 Theft and Vandalism

In general, there would be negligible potential for theft and vandalism of fossil sites because the potential for fossil finds is moderate within the Mesaverde Formation and there are no known fossil localities.

Where the conveyor crosses the outcrop of the Mancos-Dakota there is a possibility of exposed fossils which could be subject to theft or vandalism. The impacts would be negligible because the access road and conveyor would not be accessible to the public and the outcrops are vegetated and largely covered with colluvium.

3.5.4.4.2.3 Protection Measures

The protection measures for the Proposed KMC under the Natural Gas PFR Alternative would be the same as for the Proposed Action.

3.5.4.4.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

3.5.4.4.3.1 Destruction of Fossils

There would be negligible impacts to the exiting transmission systems and communication sites because no changes in the operations of the WTS, STS, or communications sites would occur due to the implementation of the Natural Gas PFR Alternative.

3.5.4.4.3.2 Theft and Vandalism

There would be no potential for theft and vandalism of fossil sites because the areas have already been disturbed and no significant fossil locations have been identified.

3.5.4.4.3.3 Protection Measures

The protection measures for the Transmission Systems and Communication Sites under the Natural Gas PFR Alternative would be the same as for the Proposed Action.

3.5.4.4.4 Project Impact Summary – All Project Components

Impacts to fossil resources for all of the project components would be negligible to none because of the generally low to moderate Potential Fossil Yield Classification rank of the bedrock formations. For the NGS and associated facilities, transmission systems and communication sites most activities would occur in previously disturbed areas with no known fossil locations.

The potential for theft and vandalism is negligible to none because of the lack of identified significant fossil locations for any of the project components. In addition, for the NGS and proposed KMC, access would be controlled for most areas limiting the potential for theft and vandalism.

3.5.4.4.4.1 Protection Measures

The protection measures as described for the Proposed Action would be the same for the Natural Gas PFR Alternative and would provide for the proper collection and curation of fossil resources.

3.5.4.4.5 Cumulative Impacts

Under the Natural Gas PFR Alternative, no reasonably foreseeable actions are expected to occur that would intersect with the cumulative effects study area for paleontological resources as defined in Section 3.5.2. Because impacts to paleontological resources are expected to be negligible to none under the Natural Gas PFR Alternative, no cumulative impacts are expected to occur. Since the transmission lines would continue to operate as presently configured, there would be no new disturbance that would impact fossil resources.

3.5.4.5 Renewable Partial Federal Replacement Alternative

Under the Renewable PFR Alternative, a selected quantity of power between 100 MW and 250 MW would be contracted for under a long-term power purchase agreement from a currently unidentified, existing renewable energy power source, displacing an equivalent amount of power from the federal share of NGS generation. Because the facility is assumed to currently exist, prior disturbance impacts to paleontological resources are not evaluated. The following is a key assumption about paleontological resources related to such an existing site:

- Loss of paleontological resources may have already occurred due to prior ground disturbance.

Impact issues for the Renewable PFR Alternative are discussed across the range of NGS unit operations (3-Unit and 2-Unit) and associated alternative power reductions (100 MW and 250 MW) from the least NGS power reduction to the greatest. Reductions in NGS power generation would proportionally reduce the quantity of coal delivered from the Kayenta Mine.

The focus of this discussion is to distinguish differences in impacts within the replacement alternative operational range to provide a basis for comparison with the Proposed Action.

3.5.4.5.1 Navajo Generating Station

3.5.4.5.1.1 Destruction of Fossils

Impacts to fossil resources would be negligible under the Renewable PFR Alternative because of the low to moderate fossil potential of the bedrock formations and limited potential for disturbance of new ground, as ground disturbance is likely to occur in areas that have already been disturbed.

3.5.4.5.1.2 Theft and Vandalism

Indirect effects from theft or vandalism are expected to be negligible because there is a low to medium potential for the occurrence of fossils in areas outside of currently disturbed areas, there are no known fossil localities, and the access to the NGS site would be controlled.

3.5.4.5.1.3 Protection Measures

The protection measures for the NGS under the Renewable PFR Alternative would be the same as for the Proposed Action.

3.5.4.5.2 Proposed Kayenta Mine Complex

3.5.4.5.2.1 Destruction of Fossils

Impacts would be negligible because important fossils are not expected in the Mesaverde that is mined. The coal conveyor and associated access road is a previously disturbed area and therefore impacts to paleontological resources would be negligible.

3.5.4.5.2.2 Theft and Vandalism

In general, there would be negligible potential for theft and vandalism of fossil sites because the potential for fossil finds is moderate within the Mesaverde Formation and there are no known fossil localities.

Where the conveyor crosses the outcrop of the Mancos-Dakota there is a possibility of exposed fossils which could be subject to theft or vandalism. The impacts would be negligible because the access road and conveyor would not be accessible to the public and the outcrops are vegetated and largely covered with colluvium.

3.5.4.5.2.3 Protection Measures

The protection measures for the Proposed KMC under the Renewable PFR Alternative would be the same as for the Proposed Action.

3.5.4.5.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

3.5.4.5.3.1 Destruction of Fossils

There would be negligible impacts to the exiting transmission systems and communication sites because no changes in the operations of the WTS, STS, or communications sites would occur due to the implementation of the Renewable PFR Alternative.

3.5.4.5.3.2 Theft and Vandalism

There would be no potential for theft and vandalism of fossil sites because the areas have already been disturbed and no significant fossil locations have been identified.

3.5.4.5.3.3 Protection Measures

The protection measures for the Transmission Systems and Communication Sites under the Renewable PFR Alternative would be the same as for the Proposed Action.

3.5.4.5.4 Project Impact Summary – All Project Components

Impacts to fossil resources for all of the project components would be negligible to none because of the generally low to moderate Potential Fossil Yield Classification rank of the bedrock formations. For the NGS and associated facilities, transmission systems and communication sites most activities would occur in previously disturbed areas with no known fossil locations. The recommended protection measures would provide for the proper documentation and recovery of unanticipated discovery of fossil resources.

The potential for theft and vandalism is negligible to none because of the lack of identified significant fossil locations for any of the project components. In addition, for the NGS and proposed KMC, access would be controlled for most areas limiting the potential for theft and vandalism.

3.5.4.5.4.1 Protection Measures

The protection measures as described for the Proposed Action would be the same for the Renewable PFR Alternative and would provide for the proper collection and curation of fossil resources.

3.5.4.5.5 Cumulative Impacts

Under the Renewable PFR Alternative, no reasonably foreseeable actions are expected to occur that would intersect with the cumulative effects study area for paleontological resources as defined in Section 3.5.2. Because impacts paleontological resources are expected to be negligible to none under the Proposed Action, no cumulative impacts are expected to occur. Since the transmission lines would continue to operate as presently configured, there would be no new disturbance that would impact fossil resources.

3.5.4.6 Tribal Partial Federal Replacement Alternative

Under the Tribal PFR Alternative, between 100 MW and 250 MW of power generation from the NGS would be replaced by power supplied by a new photovoltaic generation facility on tribal land, displacing an equivalent amount of power from the federal share of NGS generation. The construction of a new photovoltaic generation site on tribal land would result in between 1,200 and 3,000 acres of new surface disturbance. The Tribal PFR facility would be analyzed in a separate National Environmental Policy Act process once a facility location is identified.

3.5.4.6.1 Navajo Generating Station

3.5.4.6.1.1 Destruction of Fossils

Impacts to fossil resources would be negligible under the Tribal PFR Alternative because of the low to moderate fossil potential of the bedrock formations and limited potential for disturbance of new ground, as ground disturbance is likely to occur in areas that have already been disturbed.

3.5.4.6.1.2 Theft and Vandalism

Indirect effects from theft or vandalism are expected to be negligible because there is a low to medium potential for the occurrence of fossils in areas outside of currently disturbed areas, there are no known fossil localities, and the access to the NGS site would be controlled.

3.5.4.6.1.3 Protection Measures

The protection measures for the NGS under the Tribal PFR Alternative would be the same as for the Proposed Action.

3.5.4.6.2 Proposed Kayenta Mine Complex

3.5.4.6.2.1 Destruction of Fossils

Impacts would be negligible because important fossils are not expected in the Mesaverde that is mined. The coal conveyor and associated access road is a previously disturbed area and therefore impacts to paleontological resources would be negligible.

3.5.4.6.2.2 Theft and Vandalism

In general, there would be negligible potential for theft and vandalism of fossil sites because the potential for fossil finds is moderate within the Mesaverde Formation and there are no known fossil localities.

Where the conveyor crosses the outcrop of the Mancos-Dakota there is a possibility of exposed fossils which could be subject to theft or vandalism. The impacts would be negligible because the access road and conveyor would not be accessible to the public and the outcrops are vegetated and largely covered with colluvium.

3.5.4.6.2.3 Protection Measures

The protection measures for the Proposed KMC under the Tribal PFR Alternative would be the same as for the Proposed Action.

3.5.4.6.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

3.5.4.6.3.1 Destruction of Fossils

There would be negligible impacts to the exiting transmission systems and communication sites because no changes in the operations of the WTS, STS, or communications sites would occur due to the implementation of this alternative. Additional disturbance could occur to an unknown number of acres related to connecting a new photovoltaic generation site on tribal land to the existing transmission system and would be evaluated in a subsequent National Environmental Policy Act action.

3.5.4.6.3.2 Theft and Vandalism

There would be no potential for theft and vandalism of fossil sites because the areas have already been disturbed and no significant fossil locations have been identified.

3.5.4.6.3.3 Protection Measures

The protection measures for the transmission systems and communication sites under the Tribal PFR Alternative would be the same as for the Proposed Action.

3.5.4.6.4 Project Impact Summary – All Project Components

Impacts to fossil resources for all of the project components would be negligible to none because of the generally low to moderate Potential Fossil Yield Classification rank of the bedrock formations. For the NGS and associated facilities, transmission systems and communication sites most activities would occur in previously disturbed areas with no known fossil locations. The recommended protection measures would provide for the proper documentation and recovery of unanticipated discovery of fossil resources.

The potential for theft and vandalism is negligible to none because of the lack of identified significant fossil locations for any of the project components. In addition, for the NGS and proposed KMC, access would be controlled for most areas limiting the potential for theft and vandalism.

3.5.4.6.4.1 Protection Measures

The protection measures as described for the Proposed Action would apply to the other alternatives and provide for the proper collection and curation of fossil resources.

3.5.4.6.5 Cumulative Impacts

Under the Tribal PFR Alternative, no reasonably foreseeable actions are expected to occur that would intersect with the cumulative effects study area for paleontological resources as defined in Section 3.5.2. Because impacts paleontological resources are expected to be negligible to none under the Proposed Action, no cumulative impacts are expected to occur. Since the transmission lines would continue to operate as presently configured, there would be no new disturbance that would impact fossil resources.

3.5.4.7 No Action

3.5.4.7.1 Navajo Generating Station

3.5.4.7.1.1 Destruction of Fossils

Activities under the No Action Alternative would take place on previously disturbed areas and would include decommissioning and reclamation. Therefore, no impacts to paleontological resources would be expected.

3.5.4.7.1.2 Theft and Vandalism

Indirect effects from theft or vandalism are expected to be negligible because there is a low to medium potential for the occurrence of fossils in areas outside of currently disturbed areas, there are no known fossil localities, and the access to the NGS site would be controlled through completion of reclamation.

3.5.4.7.2 Proposed Kayenta Mine Complex

3.5.4.7.2.1 Destruction of Fossils

Under the No Action Alternative, mining activities would cease and the probability of loss or destruction of fossil resources would be reduced. Reclamation activities may pose a risk to fossils; therefore, the protection measures listed above for the Proposed Action should stay in place until active reclamation activities have ceased. Impacts to paleontological resources are expected to be negligible because of the low potential for scientifically important fossils in the Mesaverde Group that is mined and the protection measures in case of unexpected discovery of important fossils.

3.5.4.7.2.2 Theft and Vandalism

In general, there would be negligible potential for theft and vandalism of fossil sites since the potential for fossil finds is moderate within the Mesaverde Formation and there are no known fossil localities.

Where the conveyor crosses the outcrop of the Mancos-Dakota there is a possibility of exposed fossils which could be subject to theft or vandalism which could increase during or after reclamation. The impacts would be negligible because the access road and conveyor would not be accessible to the public until reclamation is complete. In addition, the outcrops are currently vegetated and largely covered with colluvium which would not change during site reclamation, making any potential fossils less visible.

3.5.4.7.2.3 Protection Measures

The protection measures for the Proposed KMC under the No Action Alternative would be the same as for the Proposed Action.

3.5.4.7.3 Transmission Systems and Communication Sites

The NGS transmission system is an established part of the western U.S. transmission grid and supports reliability and delivery of power throughout the region, well beyond the power generated by the NGS. Therefore, under the No Action Alternative it is likely that that one, several, or all of the land owners/managers of the transmission line rights-of-way and communication site leases would renew some portion of the facilities to keep the power grid performing as expected.

In the event it is determined that some or all of the transmission systems and communication site ROWs are not renewed, a lengthy study and permitting process would need to occur before any decommissioning is initiated due to the essential and integral nature of these facilities with the western electric grid. As noted in Section 2.3.3, up to 4,826 acres within and alongside the transmission system corridors could be temporarily disturbed if the entirety of the transmission systems and communication sites were decommissioned and removed.

3.5.4.7.3.1 Destruction of Fossils

Decommissioning activities generally would take place on previously disturbed areas which are not likely to have salvageable paleontological resources. Therefore, no impacts are expected. If work were to occur on undisturbed areas, then the protection measures as described for the Proposed Action would apply. However, the potential for impacts to fossil resources is negligible, even outside of previously disturbed areas. No impacts to paleontological resources at communication sites are expected.

3.5.4.7.3.2 Theft and Vandalism

Indirect effects from theft or vandalism are expected to be negligible because there is a low to medium potential for the occurrence of fossils in areas outside of currently disturbed areas and there are no known fossil localities.

3.5.4.7.3.3 Protection Measures

The protection measures for the transmission systems and communication sites under the No Action Alternative would be the same as for the Proposed Action.

3.5.4.7.4 No Action Impact Summary – All Project Components

Under the No Action Alternative, impacts to paleontological resources are expected to be negligible to none because of prior disturbance and protection measures that would protect loss or damage of the resource during decommissioning and reclamation. Potential impacts from mining disturbance of 5,230 acres to 4,741 acres at Kayenta Mine after 2019 would not occur. Reclamation is expected to take place within previously disturbed areas with no known fossil locations. The recommended protection measures would provide for the proper documentation and recovery of unanticipated discovery of fossil resources.

The potential for theft and vandalism is negligible to none because of the lack of identified significant fossil locations for any of the project components. In addition, for the NGS and proposed KMC, access would be controlled for most areas limiting the potential for theft and vandalism.

3.5.4.7.4.1 Protection Measures

The protection measures as described for the Proposed Action would apply to the No Action and would provide for the proper collection and curation of fossil resources.

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Section 3.6

Soil Resources

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Acronyms and Abbreviations

1969 Lease	Navajo Project Indenture of Lease
BART	Best Available Retrofit Technology
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BM&LP Railroad	Black Mesa & Lake Powell Railroad
BO	Biological Opinion
CAP	Central Arizona Project
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CO_2	carbon dioxide
COPEC	chemical of potential ecological concern
Co-tenants	Salt River Project, Arizona Public Service, NV Energy, and Tucson Electric Power Company
Development Fund	Lower Colorado River Basin Development Fund
EIS	Environmental Impact Statement
ERA	Ecological Risk Assessment
ESA	Endangered Species Act of 1973
HHRA	Human Health Risk Assessment
km	kilometer
KMC	Kayenta Mine Complex
kV	kilovolt
kW	kilowatt
MW	megawatt
N-Aquifer	Navajo Aquifer
NEPA	National Environmental Policy Act of 1969, as amended
NGS	Navajo Generating Station
NGS Participants	U.S. (Reclamation), Salt River Project, Arizona Public Service, NV Energy, and Tucson Electric Power Company
NHPA	National Historic Preservation Act
NNEPA	Navajo Nation Environmental Protection Agency
NO_2	nitrogen dioxide
NO_X	nitrogen oxide
OSMRE	Office of Surface Mining Reclamation and Enforcement
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 microns or less
PFR	Partial Federal Replacement
PWCC	Peabody Western Coal Company
Reclamation	U.S. Bureau of Reclamation

ROW	Right-of-way
SO_2	sulfur dioxide
SRP	Salt River Project Agricultural Improvement and Power District
STS	Southern Transmission System
tpy	tons per year
U.S.	United States
USEPA	U.S. Environmental Protection Agency
WTS	Western Transmission System

Contents

3.6 Soil Resources 3.6-1
3.6.1 Regulatory Framework 3.6-1
3.6.2 Study Areas 3.6-1
3.6.3 Affected Environment 3.6-1
3.6.3.1 Navajo Generating Station 3.6-3
3.6.3.2 Proposed Kayenta Mine Complex 3.6-5
3.6.3.3 Transmission Systems and Communication Sites 3.6-9
3.6.4 Environmental Consequences 3.6-10
3.6.4.1 Issues 3.6-10
3.6.4.2 Assumptions and Impact Methodology 3.6-10
3.6.4.3 Proposed Action 3.6-11
3.6.4.4 Natural Gas Partial Federal Replacement Alternative 3.6-16
3.6.4.5 Renewable Partial Federal Replacement Alternative 3.6-20
3.6.4.6 Tribal Partial Federal Replacement Alternative 3.6-23
3.6.4.7 No Action 3.6-26
3.6.5 References 3.6-27

List of Tables

Table 3.6-1 Soil Types for Project Components 3.6-2
Table 3.6-2 Background Soil Trace Metals Data Used for the NGS Baseline Risk Assessments 3.6-5
Table 3.6-3 Soil Sample Types Collected within the Proposed KMC Study Area 3.6-8
Table 3.6-4 Soil Trace Metals Data Used for the Proposed KMC Baseline Risk Assessments 3.6-8
Table 3.6-5 Major Land Resource Areas Intersected by the WTS and STS 3.6-10
Table 3.6-6 Trace Metal Deposition Comparison to Background Concentrations within NGS Study Area 3.6-12
Table 3.6-7 Trace Metal Deposition Comparison to Background Concentrations within the Proposed KMC Study Area 3.6-14
Table 3.6-8 Comparison of Trace Metal Emissions Under the Proposed Action and Natural Gas PFR Alternative 3.6-18
Table 3.6-9 Comparison of Trace Metal Emissions Under the Proposed Action and Renewable PFR Alternative 3.6-21
Table 3.6-10 Comparison of Trace Metal Emissions Under the Proposed Action and Tribal PFR Alternative 3.6-24

3.6 Soil Resources

3.6.1 Regulatory Framework

No specific federal or tribal regulations regarding soils management are applicable to the components of Navajo Generating Station (NGS) except for general conditions associated with plant site and associated facilities, and Black Mesa and Lake Powell railroad (BM&LP Railroad) decommissioning contained in the 1969 Lease and Lease Amendment No. 1 (or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1) (**Appendix 1B**).

The management of soils affected by mining is under the jurisdiction of the Office of Surface Mining Reclamation and Enforcement (OSMRE), which implements the Surface Mining Control and Reclamation Act requirements for soil protection and productivity on coal surface mines.

The management of soils on transmission systems, communication sites, and service roads are subject to the requirements of the state, federal, or tribal grantor[1] of the right-of-way (ROW), including Bureau of Land Management (BLM) and U.S. Forest Service management plans, where applicable. The Operation and Maintenance Plan (**Appendix 1B**) provides a summary of soil disturbance activities that may occur within the project study area. The primary activity is infrequent, periodic grading of existing access roads to maintain equipment passage. Graded soils would be applied to the existing road surface (**Appendix 1B**).

3.6.2 Study Areas

The study area for the Proposed Action and Alternatives is defined by existing and proposed surface disturbance. Past and present, as well as future project surface disturbance for both NGS and the proposed Kayenta Mine Complex (KMC) are summarized on **Table 3.0-1.** The cumulative impacts study areas for soils includes the NGS-KMC project components as well as other foreseeable projects which are discussed in Chapter 3.0. The key foreseeable surface disturbance actions that overlap with the NGS-KMC project are the Lake Powell water pipeline and transmission line that would parallel the Western Transmission System (WTS) near the Arizona/Utah border (**Figure 3.0-2**), and several transmission lines in the Las Vegas region that overlap with the WTS corridor (**Figure 3.0-3**).

The study areas for trace metal deposition from NGS stacks, and from proposed KMC mining activities would be the same as those described for the Ecological Risk Assessment (ERA) and Human Health Risk Assessment (HHRA) (**Figures 3.0-4** through **3.0-7**). The majority of the deposition from power plant stacks would occur within 50 kilometers (km) of NGS; the majority of the fugitive dust would be deposited within the proposed KMC lease boundary (Section 3.1, Air Quality).

3.6.3 Affected Environment

A variety of data sources were used to identify the baseline soil characteristics in the surface disturbance and trace metal deposition locations within the study areas. Information on land resource areas was obtained from Natural Resources Conservation Service literature or databases, including the Land Resource Regions and Major Land Resource Areas of the U.S., the Caribbean, and the Pacific Basin, U.S. Department of Agriculture Handbook 296 (U.S. Department of Agriculture, Natural Resources Conservation Service 2006). Previous soil surveys have been conducted across areas proposed for mining at the Kayenta Mine in accordance with Surface Mining Control and Reclamation Act requirements.

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[1] ROWs on Navajo Nation would be subject to the covenant not to regulate, contained in the current lease agreement. This covenant would not apply to the communication site on the Kaibab-Paiute Reservation, or the WTS ROW on the Moapa Paiute Reservation, which is under the jurisdiction of the BLM.

Soil characteristics within the project-specific and cumulative effects analysis areas were characterized and evaluated using the databases included in Soil Survey Geographic Database and/or State Soil Geographic Database (U. S. Department of Agriculture, Natural Resources Conservation Service 2015). Project facilities are located on soils that have formed within the Major Land Resource Areas provided on **Table 3.6-1**.

Table 3.6-1 Soil Types for Project Components

Major Land Resource Areas	NGS[1]	Proposed KMC	WTS and Communication Sites	Southern Transmission System (STS) and Communication Sites
MLRA 35 Colorado Plateau	X	X	X	X
MLRA 30 Mojave Desert	X	X	X	X
MLRA 38 Mogollon Transition	—	—	—	X
MLRA 40 Sonoran Basin and Range	—	—	—	X

[1] Includes the NGS 20-km deposition area and the BM&LP Railroad ROW corridor.

Source: U.S. Department of Agriculture, Natural Resources Conservation Service 2006.

- Major Land Resource Area 35 – Colorado Plateau. The topography of the Colorado Plateau generally consists of gently sloping to strongly sloping plains. Volcanic plugs rise abruptly above the plains and steep scarps or deeply incised canyons occur intermittently. The elevation typically ranges from 4,250 to 4,950 feet above mean sea level, and the mountains range from 8,000 to 10,385 feet above mean sea level. The Colorado Plateau has been structurally uplifted. Soil parent materials consist of shale, sandstone, limestone, dolomite, and volcanic rock. Rock outcrops are extensive. The soils on the plateaus, mesas, hillsides, and fan terraces of the Colorado Plateau range from a few inches to more than 5 feet deep and generally are well drained. Soils in many portions of the Colorado Plateau are subject to high wind and water erosion due to sparse vegetation cover, and steep slopes.
- Major Land Resource Area 30 – Mojave Desert. Broad basins, valleys, and old lakebeds make up most of the Mojave Desert Major Land Resource Area, but widely spaced mountains trending north to south occur throughout the area. Isolated, short mountain ranges are separated by an aggraded desert plain. Long alluvial fans coalesce with dry lakebeds between some of the ranges. Elevations range from 282 feet below mean sea level in Death Valley to 3,950 feet above mean sea level in valleys and basins. Some mountain ranges have peaks that exceed 11,100 feet above mean sea level. The soils in the Mojave Desert Major Land Resource Area primarily formed in alluvial deposits on alluvial fans and valley floors. Recent alluvial fans and remnant alluvial fan terraces typically grade from boulder-strewn deposits and coarse desert pavement near the fan apex to finer grained sands, silts, and clays at the lower ends. Playas are at the lowest elevations in the closed basins. They commonly have wind deposits along their downwind fringes. Water from shallow subsurface flows and surface flows that periodically fill the playa basins evaporates, leaving accumulations of evaporite minerals including salts and borates. Saline and sodic soils are common.
- Major Land Resource Area 38 – Mogollon Transition. The Mogollon Transition Major Land Resource Area consists of mountain ranges, canyons, and structural troughs and valleys. Elevations range from 3,000 to 5,500 feet above mean sea level in most areas and from 5,100 to 7,500 feet above mean sea level in the mountains. Most of this Major Land Resource Area is covered by deep alluvium washed in from the adjacent mountains. These deposits of silt, sand, and gravel occur in drainages, valley floors, and terraces. This Major Land Resource Area is an area of intensive volcanism. Isolated outcrops of granite, andesite, and basalt are common. The

soils in the Mogollon Transition Major Land Resource Area primarily formed in alluvium. They developed from igneous or metamorphic rock. The soils generally range from very shallow to very deep and are well drained to somewhat excessively drained. The primary soil resource concerns are maintenance of the content of organic matter, productivity of the soils, and the hazard of water erosion.

- Major Land Resource Area 40 – Sonoran Basin and Range. Topography in the Sonoran Basin and Range Major Land Resource Area consists of many short, fault-block mountain ranges that trend southeast to northwest and rise abruptly from the smooth or gently sloping desert valley floors. Elevations generally range from 980 to 3,600 feet above mean sea level in most of this area but can occur as high as 4,590 feet above mean sea level in the mountains. Most of this Major Land Resource Area is covered by deep alluvium washed in from the adjacent mountains. These deposits of silt, sand, and gravel occur in drainages, valley floors, and terraces. This Major Land Resource Area is an area of intensive volcanism. Isolated outcrops of granite, andesite, and basalt are common. The soils in the Sonoran Basin and Range primarily formed in alluvium. They developed from igneous or metamorphic rock. The soils generally range from very shallow to very deep and are well drained to somewhat excessively drained. The primary soil resource concern is the absence of soil sustainability, resulting in no soil loss tolerance within this extremely arid environment. Other resource concerns include declining water tables and accumulation of salts in irrigated soils.

3.6.3.1 Navajo Generating Station

3.6.3.1.1 Surface Disturbance

Through 2019, surface disturbance from operation of the NGS and associated facilities, BM&LP Railroad, and coal combustion residuals disposal area and road is estimated to be 3,485 acres (**Table 3.0-1**). Of this total, the majority of the railroad track embankment area, and 107 acres of the west face of the coal combustion residuals disposal area have been revegetated. The remainder of the area is committed to industrial uses with no native soil cover on disturbed surfaces.

3.6.3.1.2 Soil Quality

Limited soil chemistry information, particularly for trace metals and other pollutants are available from published sources for the immediate area around NGS. As a consequence, surface and near-surface soil sampling was conducted in the vicinity of NGS and within the proposed KMC in 2015.

As described in the NGS Sampling Investigation Report (Ramboll Environ 2016f) soil samples were collected within the 20-km deposition radius from the NGS, within the near-field study area. The samples were tested for metals, organics, pH, and acid neutralization potential to characterize current conditions of soils in the vicinity of the NGS. Sampling was conducted in natural communities to provide input to the ERA, and also in the communities of Page and LaChee to provide background for the HHRA. Figure 2-2B in the NGS Sampling Investigation Report (Ramboll Environ 2016f) illustrates the major soil units within the NGS near-field and the soil sampling locations.

Within the NGS near-field area, potential ecological risk associated with emissions that are deposited on terrestrial and aquatic habitats were evaluated through data collected from regional geochemical data bases (Smith et al. 2013) to develop an estimate of the regional background for a variety of constituents including; soil, sediment, and surface water to establish baseline conditions. Baseline conditions refer to the current environmental conditions before any future project activities have taken place. Future project activities begin in 2020. Hazard quotients were calculated for each chemical of potential ecological concern (COEPC). COPECs analyzed in the NGS near-field analysis include inorganic chemicals (metals like mercury and selenium) and organic chemicals, specifically dioxins/furans and polycyclic aromatic hydrocarbons formed during the incomplete burning of coal. Hazard quotients are a ratio of estimated chemical concentrations and the appropriate ecological screening value at or below which impacts to a given species from exposure to a chemical are unlikely. The hazard quotient is not a predictor of risk but rather is an indicator of whether or not there is a potential for risk. Detailed information on how hazard quotients are calculated and how they are interpreted is described in Section 3.0.3, Ecological and Human Health Risk Assessments.

The tiered approach recommended by the U.S. Environmental Protection Agency (USEPA) was adopted in the NGS near-field ERA. “Screening” and “refined” scenarios were used to look at the potential of risk. The screening scenario is a conservative analysis using maximum concentrations of COPECs. The refined scenario is conducted when a potential risk is detected at maximum exposures to COPECs. The refined evaluations consider alternative exposure concentrations, represented by the 95 percent upper confidence limit and average exposure concentrations. This approach is consistent with the USEPA’s Screening Level ERA Protocol, which indicates additional risk assessment calculations can be performed using information more representative of the actual exposure setting rather than the maximum. Hazard quotient value based on the 95 percent refined scenario is considered to be the more realistic indicator of ecological risk rather than the hazard quotient based on maximum exposure. This is because receptors are unlikely to be exposed to the highest levels of all COPECs at all times. For evaluation of soils, if the refined hazard quotient for a given COPEC is less than or equal to one, risk to vegetation and wildlife species, and human receptors from that particular chemical is not likely. If the hazard quotient is greater than one, ecological risk is evaluated further using other lines of evidence.

Table 3.6-2 provides a summary of the regional background concentrations of trace metals based on a large number of samples (Smith et al. 2013), and soil surface sampling that was conducted at multiple locations in the vicinity of NGS.

In general, the metals detected in the soil samples were consistent with regional background soil conditions. Volatile organic compounds were not detected. Total mercury, selenium, and methylmercury were infrequently detected. Arsenic was widely distributed at low concentrations and is considered to be naturally occurring. There were no distinct spatial patterns of compound occurrence or concentrations that would suggest the influence of NGS historic emissions and deposition; thus, the sampling data and concentrations were considered reflective of baseline conditions for the area (Environ 2016g).

The maximum selenium and mercury background soil concentrations would be below USEPA ERA and HHRA screening levels. The maximum background levels of arsenic would be below the USEPA ERA screening level, but above the human health screening level. The evaluation of arsenic in the HHRA at a refined level of analysis (using the 95 percent upper confidence limit) indicated that arsenic did not cause an unacceptable baseline cancer risk to human receptors of all types (Section 3.16, Public Health).

The maximum hazard quotients for baseline (current) conditions were all below one, indicating that there would be no potential for adverse effects to soils under baseline conditions.

Table 3.6-2 Background Soil Trace Metals Data Used for the NGS Baseline Risk Assessments

Chemical	Soil Source/Risk Assessment	Minimum (mg/kg)	Maximum (mg/kg)	Mean (mg/kg)	95% UCL (mg/kg)
Arsenic	NGS Near-field (20-km) Samples[1]	0.086	7.1	0.86	1.1
	150 km Background[2]	1.0	31.1	4.88	5.42
	Background for Arizona[2]	1.1	32.0	5.96	6.95
Mercury	NGS Near-field (20-km) Samples[1]	0.0016	0.018	0.0044	0.0053
	150 km Background[2]	0.01	0.04	0.013	0.016
	Background for Arizona[2]	0.01	0.35	0.021	0.023
Methylmercury	NGS Near-field (20-km) Samples[1]	0.00005	0.00041	0.00004	0.00005
	150 km Background[2]	NA	NA	NA	NA
	Background for Arizona[2]	NA	NA	NA	NA
Selenium	NGS Near-field (20-km) Samples[1]	0.059	0.20	0.041	0.033
	150 km Background[2]	0.2	1.0	0.186	0.287
	Background for Arizona[2]	0.2	1.0	0.229	0.237

[1] Field data collected in 2014. Summary values from Table A-2 in the NGS Near-field ERA (Ramboll Environ 2016a), Table A-2D in the San Juan River ERA (Ramboll Environ 2016b), and Table A-2C in the Gap Regions ERA (Ramboll Environ 2016c). Maximum, mean, and 95 percent UCL values used as baseline soil model input values to calculate the hazard quotient maximum, hazard quotient average, and hazard quotient refined values, respectively for the NGS Nearfield ERA (Tables A-4A and A-4B in Ramboll Environ 2016a), San Juan River ERA (Tables A-3A and A-3B in Ramboll Environ 2016b), and Gap Regions ERAs (Tables A-3A and A-3B in Ramboll Environ 2016c).

[2] ERA background summary values from Table 4-2C in the NGS Sampling Investigation Report (Ramboll Environ 2016f).

mg/kg = milligrams per kilograms.

NA = Not available.

ND = Not detected.

UCL=upper confidence limit.

No soil sampling was conducted along the BM&LP Railroad to characterize trace metal concentrations. Particulate coal matter from rail transport is considered to have very little impact outside of the railroad ROW. A single residence lies within 100 meters of the rail line. The large separation distance and restricted access to the rail line make public exposure to coal dust very low (Winges and Steffel 2016).

3.6.3.2 Proposed Kayenta Mine Complex

3.6.3.2.1 Surface Disturbance

The aggregate surface disturbance from coal mining, construction and operation of surface facilities, and infrastructure supporting mining activities (roads, conveyor) on the former Black Mesa Mine, and the Kayenta Mine through 2019 is estimated to be 26,187 acres (Lehn 2016). Of this total, approximately 16,000 acres have been topsoiled and reseeded through 2015. With the exception of Pre-Law lands that did not receive a topsoil material cover, all reclaimed areas under the Initial and Permanent programs conform to Surface Mining Control and Reclamation Act requirements, including regrading so that slope contours approximate the original land form; reapplying soils and soil/overburden mixtures that are suitable for revegetation; and applying revegetation mixtures and plantings to meet future land use goals (**Appendix 1D**, Section 1.3.7). No permanent program areas have received Phase III bond release, which is the final assessment that confirms if reclaimed areas have met the Surface Mining Control and Reclamation Act requirements. See Section 3.14, Land Use, for further information on the ongoing reclamation program and bond release.

3.6.3.2.2 Soil Quality

Soils within the coal resource areas N-9, N-10, N-11 Extension, J-19, J-21, and J-21 West were derived from the Cretaceous Mesaverde Group; a series of sedimentary sandstones, siltstones, and mudstones. In 1979, 1983, 1985, 2000, and 2003, site-specific soil surveys were conducted in accordance with Surface Mining Control and Reclamation Act to provide detailed soil taxonomy and determine thickness of suitable topsoil, subsoil, and unconsolidated material for reclamation use. These surveys identified 14 soils in and surrounding the area. These soils were predominantly very fine- to fine-grained sandy loams with minor smectitic clayey soils. Smectite clays, also referred to as swelling clays, can undergo as much as a 30 percent volume change due to wetting and drying. Soils in the area generally are characterized as well drained with moderate shrink-swell potential and slightly susceptible to wind erosion (OSMRE 2011).

Topsoil is essential for reestablishing native vegetation and forage on reclaimed surface mines. Subsoil and weathered rock overburden beneath the topsoil supply additional nutrients and moisture for plant growth. The removal and replacement of all topsoil is required by Surface Mining Control and Reclamation Act (30 Code of Federal Regulations 816.22) unless it is demonstrated that selected subsoil, weathered overburden, or spoil is better suited for growing plants

During the topsoil salvage process, the top layers are removed and either hauled directly to a reclamation area for reapplication or stored in stockpiles for later use. Studies have shown that the largest disturbance to soils is the initial removal of soils from the site. The top horizon is a highly aggregated, nutrient rich layer, higher in organic matter and microorganisms. The second horizon taken during salvage is typically the same or similar type of soil but consists of less nutrients, organisms, and organic material. When the two layers are stripped, the biological activity of the surface horizon degrades immediately due to mixing with the second, less rich layer.

Stockpiling soils results in reduced infiltration rates and water holding capacity, and a reduction or total loss of organisms such as bacteria, fungi, and small invertebrates (Pranger 2000). Further impacts associated with stockpiling include loss of viable seed communities which promote native vegetation growth and wildlife foraging. Compaction occurs in large stockpiles, reducing oxygen required for respiration at depths of a meter or deeper in the stockpile (Stahl et al. 2000). At depths of one meter or greater in stockpiles, anaerobic bacteria populations increase and aerobic bacteria populations decrease inhibiting nitrification from poor aeration of the soils (Sheoran et al.). Carbon and nitrogen are reduced and soil pH increases in stockpiled soils (Wick et al. 2008). These changes are attributed to the mixing of horizons that occur with the salvaging process.

Direct haul results in the same soil mixing impacts as stockpiling because soil stripping methods are the same. However, direct haul soils provide an immediate revegetation recovery response from the initial disturbance, whereas stockpiled soils must be disturbed a second time when transported for reclamation. Additionally, direct haul soil management allows soils to be placed evenly across an area with depths not generally exceeding one meter. This reapplication approach promotes seed viability, prevents nutrient loss from runoff and erosion and further reductions of carbon and nitrogen.

By definition, topsoil means the A and E soil horizon layers of the four master soil horizons (30 Code of Federal Regulations 701.5). The soils of the proposed KMC have A horizons that range in thickness between 1 inch and 4 inches, depending on the soil. Topsoil may be of insufficient quantity to salvage as a separate layer and must be salvaged together with suitable subsoil and suitable unconsolidated material below the subsoil to provide an average 2-foot-thick topsoil mixture suitable for reclamation.

When a more rocky topsoil material is needed to support the reclamation plan, Peabody Western Coal Company (PWCC) salvages the suitable residual soils unless their depth makes salvage impractical. The soil surveys assess residual soil suitability for reclamation based on seven conditions: selenium concentration, sodic zones, pH, saline strata, texture, rock fragment percentage, and acid-forming spoils.

Graded spoil sampling is an integral part of the reclamation process that ensures a suitable root zone to meet the post-mining land use and that all exposed acid-forming materials are covered. PWCC conducts graded spoil sampling to identify and minimize potentially adverse effects on plant growth and the approved post-mining land use (30 Code of Federal Regulations 715.14 (j), and 816.102(f)). Samples are collected on a grid pattern and analyzed for pH, electrical conductivity, sodium adsorption ratio, percent clay, percent rock fragments, calcium carbonate, and acid-based potential. If maximum thresholds are exceeded for any value indicating that the material could adversely affect plant growth or contribute to toxic levels of elements or compounds in above ground plant parts, the grid is narrowed until the full extent of the potentially unsuitable overburden is determined. Additional overburden/ spoil/topsoil is hauled to cover the area of unsuitable material so that the combination of suitable spoil/overburden and topsoil buries the unsuitable material at least 4 feet. PWCC maintains an inventory of unsuitable graded spoil and suitable soil supplements which is updated on an annual basis. Overall, a 4-foot-thick suitable root zone is created to meet Surface Mining Control and Reclamation Act requirements and reclamation plan goals using a combination of this topsoil mixture underlain with suitable spoil (**Appendix 1D**).

Sodium adsorption ratios over a range of 16 to 40, depending on soil texture, are indicative of elevated sodium in soil, which commonly represents a revegetation constraint (PWCC 2012 et seq.). Overburden materials having elevated sodium adsorption ratios also may have unsuitable pH values: either alkaline pH values greater than 8.8, or acidic pH values less than 5.5. Acidic and acid-forming spoils exist in small localized areas but the graded spoil sampling program mitigates any unsuitable areas by removal or covering to ensure a 4 feet suitable root zone.

Soils in the proposed KMC have the potential for higher than normal selenium concentrations PWCC's geobotanical studies demonstrated that selenium-accumulating plant populations are locally common. The selenium accumulators occurred on the shallow soils associated with wooded ridges and disturbed areas, and were absent from the broad sagebrush valleys and wash terraces where the deeper soils occur. Overburden material, which could be used to provide soil in reclamation areas, also was evaluated for selenium. Initial results indicated the probability of suspect concentrations of plant-available selenium occurring in regraded spoils. Based on the results of selenium analysis in plants and soils at a representative cross section of sites where accumulator plants were found, the soils in which they were growing were not seleniferous. No selenium poisoning of livestock has been reported in or surrounding the Kayenta Mine permit area. Analysis of selenium levels of regraded spoil in comparison to selenium blood levels in cattle grazing on reclaimed areas indicate the selenium levels present in regraded spoil do not pose a threat to livestock and in fact are at or slightly below levels desired for cattle. Selenium supplements are often added to salt blocks used by the local ranchers (OSMRE 2011). Substantial sampling of topsoil, overburden, and reclaimed soil-spoil in 2014 at the proposed KMC indicates selenium levels are low to normal (see **Table 3.6-2** and **Table 3.6-4**).

For the purpose providing data for the ecological and HHRAs, surface and subsurface soil samples were collected within the proposed KMC in the vicinity of residences (Ramboll Environ 2016g); on adjacent lands where special status species may occur; within sensitive areas for the Navajo sedge to the north and northwest of the mine; and sensitive areas for the Mexican spotted owl to the northeast of the mine.

Sixty-five surface soil samples were collected from 59 locations within the proposed KMC study area in 2014. The types of sites and distribution of samples are summarized in **Table 3.6-3**.

Table 3.6-3 Soil Sample Types Collected within the Proposed KMC Study Area

Site Type	Sampling Location and Intensity
Reclaimed areas	Eight surface soil samples were collected from eight locations.
Residential areas	Twenty-one surface soil samples were collected from 19 locations in residential areas.
Topsoil areas	Nine surface soil samples were collected from eight locations in both disturbed and undisturbed areas.
Overburden areas	Eight surface soil samples were collected from eight locations.
Navajo sedge areas	Ten surface soil samples were collected from eight locations in areas supporting the Navajo sedge, a federally listed plant species
Mexican spotted owl areas	Nine surface soil samples were collected from eight locations in areas potentially supporting the Mexican spotted owl.

Table 3.6-4 provides a summary of the trace metal concentration results of regional background studies, as well as recent sampling for key trace metals and other chemicals at the 59 sampling locations.

Table 3.6-4 Soil Trace Metals Data Used for the Proposed KMC Baseline Risk Assessments

Chemical	Soil Source/Risk Assessment	Minimum (mg/kg)	Maximum (mg/kg)	Mean (mg/kg)	95% UCL (mg/kg)
Arsenic	Proposed KMC ERA[1]	0.12	10	3.01	3.49
	Proposed KMC Resident HHRA[2]	1.05	9.03	3.39	4.11
	150 km Background[3]	1.0	13.8	3.82	4.22
	Background for Arizona[3]	1.1	32	5.96	6.95
Mercury	Proposed KMC ERA[1]	0.002	0.219	0.029	0.046
	Proposed KMC Resident HHRA[2]	0.008	0.092	0.027	0.034
	150-km Background[2]	0.01	0.04	0.011	0.013
	Background for Arizona[2]	0.01	0.35	0.021	0.023
Methylmercury	Proposed KMC ERA[1]	0.00003	0.0016	0.0002	0.0002
	Proposed KMC Resident HHRA [2]	0.00004	0.0016	0.0003	0.0007
	150-km Background[2]	NA	NA	NA	NA
	Background for Arizona[2]	NA	NA	NA	NA

Table 3.6-4 Soil Trace Metals Data Used for the Proposed KMC Baseline Risk Assessments

Chemical	Soil Source/Risk Assessment	Minimum (mg/kg)	Maximum (mg/kg)	Mean (mg/kg)	95% UCL (mg/kg)
Selenium	Proposed KMC ERA[1]	ND	ND	ND	ND
	Proposed KMC Resident HHRA[2]	ND	ND	ND	ND
	150-km Background[2]	0.2	1.0	0.14	0.25
	Background for Arizona[2]	0.2	1.0	0.23	0.24

[1] Field data collected in 2014. Summary values from Table A-2 in the KMC ERA (Ramboll Environ 2016g). Minimum and maximum concentrations were determined from detected concentrations; means were calculated using one-half method detection limit for non-detected chemicals. Maximum, mean, and 95 percent upper confidence limit values used as baseline soil model input values to calculate the hazard quotient maximum, hazard quotient average, and hazard quotient refined values, respectively for the KMC ERA (Tables A-4A and A-4B in Environ 2016g).

[2] Summary values calculated from residential sample values as presented on Table 4-1A in the KMC Sample Investigation Report (Ramboll Environ 2016g). Calculated 95 percent UCL values were used as baseline model input values to calculate the Resident hazard quotient values for the KMC HHRA (Table 6 in Flatirons Toxicology 2015).

[3] Summary values from Table 4-2A in the KMC Sample Investigation Report (Ramboll Environ 2016g). Minimum and maximum concentrations were determined from detected concentrations; means were calculated using one-half MDL for non-detected chemicals.

mg/kg = milligrams per kilograms.

NA = Not available.

ND = Not detected.

Key chemicals were detected at low concentrations and dispersed throughout the proposed KMC study area with no distinct patterns of occurrence, and reflect baseline conditions for the area. Arsenic and total mercury were found to be widely distributed across the study area at low concentrations. Selenium was not detected in surface soils, and methylmercury and total polycyclic aromatic hydrocarbons were infrequently detected (Ramboll Environ 2016g).

A prime farmland assessment was conducted across all lands proposed for surface mining. The soils that occur predominantly are in the Natural Resources Conservation Service land capability Classes VI and VII. Soils in Classes VI and VII have severe to very severe limitations that make them unsuitable for cultivation and limit or restrict their use largely to pasture, range, woodland, or wildlife habitat. Soils in these groupings are primarily used for livestock grazing. The land in the proposed KMC study area has received a negative determination as prime or unique farmland from the Natural Resources Conservation Service (OSMRE 2011).

3.6.3.3 Transmission Systems and Communication Sites

The transmission systems cross, and communication sites are sited on soils that have formed within the four Major Land Resource Areas. Soils located along established transmission lines and communication sites were disturbed for facility construction approximately 40 years ago. Based on an aerial photography review, the majority of the transmission system ROWs have revegetated to a native vegetation community comparable to adjacent undisturbed vegetation communities. Total surface disturbance from construction of transmission lines, substations, switchyards, and access roads is estimated to be 22,964 acres (**Table 3.0-1**). Because of continued use, access roads have not been revegetated. Prior disturbed areas within the transmission system ROW or communication sites would not require redisturbance, and are not expected to incur extensive disturbance associated with maintenance activities as outlined in the Navajo Project Operation and Maintenance Plan (**Appendix 1B**). **Table 3.6-5** summarizes each transmission system and the miles crossed through each Major Land Resource Area. Section 3.6.2 gives a brief description of these Major Land Resource Areas.

Table 3.6-5 Major Land Resource Areas Intersected by the WTS and STS

Major Land Resource Area	WTS Intersected (miles)	STS Intersected (miles)
Major Land Resource Area 30, Mojave Desert	149.1	—
Major Land Resource Area 35, Colorado Plateau	126.1	111.9
Major Land Resource Area 38, Mogollon Transition	—	75.1
Major Land Resource Area 40, Sonoran Basin and Range	—	68.6

3.6.4 Environmental Consequences

3.6.4.1 Issues

Two soil issues are associated the Proposed Action and project alternatives.

Issue 1 – Surface Disturbance/Erosion

- Soil loss and mixing as the result of surface disturbance from new facility construction and mining; risk of unprotected soil erosion from wind and water.

Issue 2 – Trace Metals Deposition from NGS Stack Emissions or from Suspended Particulates

- Deposition of trace metals (primarily from NGS stack emissions, and dust from the proposed KMC onto the soil surface), which then may serve as a source for tissue bioaccumulation in humans, aquatic organisms, terrestrial plants, and terrestrial animals, leading to varying levels of toxicity.

3.6.4.2 Assumptions and Impact Methodology

The following assumptions were used to evaluate project impacts.

- For any new project surface disturbance activity suitable soils will be stripped, stockpiled, replaced over the disturbed area, and revegetated using plant species that are appropriate for the land use and for maintaining soil stability in accordance with Navajo Nation lease agreements for NGS; and the proposed KMC in accordance with PWCC's approved reclamation plan (PWCC 2012 et seq.) and Surface Mining Control and Reclamation Act requirements administered by OSMRE.
- Disturbed soils will be protected against wind and water erosion during the revegetation period using best management practices outlined in **Appendices 1B** and **1D**.
- New soil surface disturbance was calculated from the area of initial disturbance plus a small additional buffer to account for potential soil erosion. The assumptions for buffers on linear facilities (roads, transmission lines, pipelines) are provided in the footnotes to **Table 3.0-1**.
- The entire area of the proposed KMC coal resource areas was assumed to be disturbed to account for pit access roads, soil stockpiles, and overburden placement beyond the mine pit boundaries.

3.6.4.3 Proposed Action

3.6.4.3.1 Navajo Generating Station

3.6.4.3.1.1 Surface Disturbance/Erosion

No new soil disturbance would be required within areas that were previously cleared for plant site construction and operation. These areas include all power generation facilities within the plant site boundary, coal storage areas, wastewater ponds, and landfills. While additional water processing ponds may be added in the future, they would be located entirely within previously graded areas. No additional soil disturbance would be required for the water supply pump station, and the pipeline, road, and transmission line that connect the pump station to the plant site (**Appendix 1B**). Power plant operations would result in new direct soil impacts primarily where soil would be stripped and stockpiled at the coal combustion residuals landfill, as follows:

Coal Combustion Residuals Disposal Area

Soils overlying the coal combustion residuals landfill site primarily consist of unconsolidated sands with minimal soil horizon development. Soil material from approximately 200 additional acres may be stripped, stockpiled, and reapplied from 2020 to 2044 for use in the landfill under the 3-Unit Operation. If 3 units operated through 2044, current coal combustion residuals landfill capacity would be exceeded (**Appendix 1B**, Figure 25). As a consequence, the landfill would be enlarged to accommodate the additional ash. It is assumed that the surface area of the expansion would be 20 percent larger than the area remaining after 2019, or 40 acres. If the 2-Unit Operation were implemented, approximately one-third less coal combustion residuals would be placed in the landfill and no enlargement of the existing landfill footprint would be necessary.

Excavated and graded soils would be protected in accordance with procedures outlined in the Navajo Project Operation and Maintenance Plan (**Appendix 1B**). Erosion control measures would be implemented to ensure soil does not leave the coal combustion residuals landfill or rest of the plant site by water erosion. NGS would implement fugitive dust suppression best management practices (e.g., maintaining road stabilization material and watering soils during earth moving activities) to minimize soil wind erosion (**Appendix 1B**).

Soil contamination could occur during operating and maintenance activities due to chemical storage, fuel or lubricant spills. If spills were to occur, they would result in localized impacts and could require removal of contaminated soils. All operation and maintenance activities would follow the procedures in the Operation and Maintenance Plan including but not limited to compliance with a Spill Prevention, Control, and Countermeasure Plan for all NGS an associated facilities (**Appendix 1B**).

BM&LP Railroad

The railroad would continue operations, and the surface footprint would not be enlarged during the period 2020 to 2044. Operation and maintenance activities would occur within the existing ROW in previously disturbed areas, and may include improvements to the electrical system, track repairs, and improvements at road and natural drainage crossings.

Decommissioning

The NGS would be decommissioned at the end of its operational life, which would require demolition and removal of some of the existing structures and recycling or placement of demolished material in landfills on-site or potentially in approved locations off-site. Structures that would remain include the water supply pump station and pipeline; administration and visitor's buildings; machine, welding, and electric shops and warehouses; existing roads and fences (**Appendix 1B**).

The existing surface disturbance footprint would not be enlarged. As required in the lease, the land would be restored as closely as possible to its original condition. The areas that do not contain permanent facilities would have all nonindigenous material removed from the surface, the area would be filled and graded in order to provide proper drainage but there would be no attempt to return the leased lands or the ROWs to the preconstruction elevations. All restored land would be covered with topsoil indigenous to the area, and revegetated with native plants in order to meet the lease requirements.

Decommissioning of the BM&LP Railroad would include removal of track and the overhead electrical system. The railroad tracks would be removed, but the existing embankments would remain in place. The specific demolition sequence has not been determined, but several options are available. The Decommissioning requirements as described above for NGS are the same for the railroad ROW.

Potential soil and wind erosion would be subject to existing intensive surface management programs for both site erosion control and sedimentation, and for maintenance of short- and long-term stability of the surface cover over the coal combustion residual landfill. During decommissioning, the majority of the plant site would be regraded, topsoil materials applied, and the site reseeded by the end of 2046. In the long term, the site would be slowly revegetated in response to low annual precipitation. The impacts of these activities across the operating range of the Proposed Action would be moderate because new surface disturbance and surface restoration during decommissioning would be at a large scale (3,684 to 3,724 acres) but would be managed in accordance with soil resource protection measures required under Navajo Nation lease terms.

3.6.4.3.1.2 Trace Metals Deposition from NGS Stack Emissions

Power plant stack emissions release particulates to the air which are deposited onto the soil surface at varying distances from the source. The deposition of these metals over time onto soils is information needed to conduct ERA and HHRAs. Deposition is expressed in milligrams of trace metals per kilogram of soil. These estimates for the 2020-2044 operating period were developed from the near-field AERMOD air quality modeling (Environ 2016a) and are shown on **Table 3.6-6**. The majority of the trace metal deposition would occur within 50 km of NGS. The trace metal deposition concentrations divided by background soil concentrations range from less than 1 percent for arsenic; 1 to 2 percent for total mercury; and 4 to 6 percent for selenium. The fate of trace metals deposited on the soil surface could take a number of pathways: they could be further dispersed by wind in dust; could become bound in the surface soil; could move deeper into the soil profile in a soluble form; or could be taken up by plant roots depending on the ionic state of the metal.

Table 3.6-6 Trace Metal Deposition Comparison to Background Concentrations within NGS Study Area

Pollutant	3-Unit Operation (mg/kg)[1]	2-Unit Operation (mg/kg)[2]	Background Concentration 95%UCL (mg/kg)[3]	Deposition Concentration/ Background Concentration (percent)
Arsenic	0.00106	0.00094	1.1	0.096%- 0.085%
Mercury (total)	0.00079	0.00054	.046	1.7%-1.1%
Selenium	0.00202	0.00137	.033	6.1%-4.1%

[1] Appendix B-1 Food Web Input Parameters for B2 (3 Unit) Maximum Concentrations for All Media (Surface Water, Sediment and Soil). Page 233, Ramboll Environ 2016a.

[2] Appendix A-1 Food Web Input Parameters for A1 (2 Unit) Maximum Concentrations for All Media (Surface Water, Sediment and Soil). Page 233, Ramboll Environ 2016a.

[3] Ramboll Environ (2016f).

Soil deposition from NGS stacks, combined with background soil concentrations would be below USEPA ERA and HHRA screening levels for selenium and mercury. The background levels of arsenic would be below the USEPA ERA screening level, but above the human health screening level. The evaluation of arsenic in the HHRA at a refined level (95 percent upper confidence limit) indicated that arsenic did not cause an unacceptable baseline cancer risk to human receptors of all types, and the contribution from NGS under all alternatives is very small, and would not change the conclusion that the cancer risks were within acceptable USEPA levels (Section 3.16, Public Health). Based on AERMOD modeling, and the ERA and HHRAs, impacts of trace metal deposition from the NGS stacks would be minor.

3.6.4.3.2 Proposed Kayenta Mine Complex

3.6.4.3.2.1 Surface Disturbance/Erosion

Under the Proposed Action all mining through the life-of-mine would occur within the proposed KMC. Vegetation clearing, topsoil removal, and mining methods would continue as described for the existing operations (PWCC 2012 et seq.). Additional topsoil stockpiles and additional drainage and sediment control structures would be added as mining progresses (PWCC 2012 et seq.). Disturbed areas would be restored to approximate landforms that existed prior to mining and would support vegetation similar to surrounding areas. As discussed previously, reclamation procedures would create a suitable 4-foot thick plant root zone over the entire reclaimed area and establish a diverse and permanent vegetation cover.

Mining under the Proposed Action would result in a disturbance range of 5,230 acres for the 3-Unit Operation to 4,741 acres under the 2-Unit Operation. All areas disturbed in the future would be subject to bond release through OSMRE. The time frame for all reclaimed areas to meet revegetation standards and be released back to the Navajo Nation or Hopi Tribe likely would require 10 to 15 years after mining ceases.

The impacts of surface coal mining would be moderate because of the relatively large area of new surface disturbance (ranging from 5,230 acres under an 8.1 million ton per year operation to 4,741 acres under a 5.5 million ton per year operation). The potential loss of soil materials from wind and water erosion over the short term (1 to 5 years) would be reduced by intensive surface management programs for soil salvage, soil erosion control, sedimentation control, and revegetation (**Appendix 1D**, Section 1.3). In the long term (5 to 10 years or longer) revegetated areas must meet performance standards for vegetation cover and diversity to achieve bond release. These standards also would serve to insure that soils are stabilized. Over the long term, soil productivity and stability should exceed premining conditions (OSMRE 2011, 2008).

3.6.4.3.2.2 Trace Metal Deposition from Suspended Particulates (Dust)

Mining activities (overburden and coal excavation, blasting, trucks traversing haul roads) release particulates to the air which are deposited onto the soil surface at varying distances from the source. Estimates for the 2020-2044 operating period were developed from the near-field air quality modeling (Ramboll Environ 2016h) and deposition modeling by McVehil-Monnett Associates, Inc. (2016). The majority of the trace metal deposition would occur within the proposed KMC boundary. The air quality modeling includes deposition contributions from NGS on proposed KMC soils because of the high NGS stacks that result in long range dispersal, prevailing winds from the west toward the proposed KMC, and short distance between sources (80 miles) (Section 3.1); proposed KMC particulates are not predicted to reach NGS because particulate generation occurs close to the ground and is localized, and the proposed KMC is downwind of NGS.

The trace metal deposition over the 2020-2044 operating period divided by background soil concentrations range from 4 percent for total mercury, and between 4.6 and 5 percent for selenium and arsenic (**Table 3.6-7**).

Based on AERMOD modeling, impacts of trace metal deposition from particulates would be minor. Particulate deposition, combined with background soil concentrations would be below USEPA ERA and HHRA screening levels for mercury and selenium. The background levels of arsenic would be below the USEPA ERA screening level, but above the human health screening level. The evaluation of arsenic in the HHRA at a refined level (95 percent UCL) indicated that arsenic did not cause an unacceptable baseline cancer risk to human receptors of all types, and the contribution from NGS is small (5 percent) (Section 3.16, Public Health).

Table 3.6-7 Trace Metal Deposition Comparison to Background Concentrations within the Proposed KMC Study Area

Pollutant	3-Unit NGS Operation- 8.1 million tpy Coal (mg/kg)	2-Unit NGS Operation- 5.5 million tpy Coal (mg/kg)	Background Concentration 95%UCL (mg/kg)	Deposition Concentration/ Background Concentration (percent)
Arsenic	0.175	0.171	3.49 [1]	5%-4.8%
Mercury (total)	0.00195	0.00189	.046[1]	4.2%-4.1%
Selenium	0.0117	0.0114	.025[2]	4.7%-4.6%

1 Samples taken within proposed KMC lease boundary used for ERA inputs.

2 Samples taken within proposed KMC lease boundary were non-detect for selenium; background represents area within 150 km of the proposed KMC.

3.6.4.3.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

3.6.4.3.3.1 Surface Disturbance/Erosion

Any surface disturbing activities along the transmission ROWs for operations or maintenance would result in vegetation removal and exposure of small areas of soil to wind and water erosion. These activities would occur intermittently, and impacts would be localized to areas where maintenance occurs. Operators of the WTS and STS would implement committed measures to minimize soil erosion impacts (e.g., avoiding working in wet soils to avoid ruts and erosion as feasible; see **Appendix 1B**). Any new surface disturbance off existing access roads would require separate approval by the land management agency or land owner.

Soil contamination could occur during maintenance activities due to fuel or lubricant spills. If spills were to occur along the ROW, they would result in localized impacts and could require removal of contaminated soils. All operation and maintenance activities would follow the spill prevention procedures in the Operation and Maintenance Plan (**Appendix 1B**).

Traffic on surface access roads during transmission line operations would result in soil compaction or rutting if soils are saturated. Rutting occurs when the soil strength is not sufficient to support the applied load from vehicle traffic. Rutting diverts and concentrates water flows and could cause accelerated erosion and sedimentation to connected waterbodies. Permanent access roads without adequate erosion controls or proper maintenance would degrade and erode. However, as noted above the operators would work to minimize work during wet period to minimize rutting and erosion. Road maintenance provisions are included in the Navajo Project Operation and Maintenance Plan (**Appendix 1B**) for both the WTS and STS.

No additional surface disturbance to maintain existing communications sites is expected.

The impacts to soils would be minor because of the small expected new surface disturbance required for transmission line and communication site repairs, and existing federal agency required measures and project proponent commitments to reduce road damage during wet conditions, and to avoid alteration of existing drainage patterns that could cause sedimentation outside the access road ROW (**Appendix 1B**).

3.6.4.3.4 Project Impact Summary – All Project Components

Impacts from the combined NGS and proposed KMC new soil disturbance from 2020 to 2044 would be moderate because a relatively large area would be disturbed (ranging from 5,230 acres under a NGS 3-Unit Operation to 4,741 acres under the 2-Unit NGS Operation) (**Table 3.0-1**). The salvage and protection of soil would be conducted in accordance with Navajo Nation lease terms for NGS, and in accordance with Surface Mining Control and Reclamation Act regulations and standards administered by OSMRE. WTS and STS transmission operation and maintenance activities would contribute very little new surface disturbance (likely less than 100 acres) over the 2020-2044 operating period. By 2044, assuming NGS and Kayenta Mine closure and demolition, up to 3,724 acres that includes the NGS plant site, railroad, and coal combustion residual landfill would require reapplication of soil materials and revegetation after demolition; a range of 9,000 to 10,000 acres of proposed KMC mined area and demolished surface facilities would require topsoiling and reseeding.

Impacts from selenium and mercury deposition from both NGS and the proposed KMC would be minor because predicted trace metal deposition over the 2020-2044 operating period would be localized (primarily within 50 km of NGS, and within the proposed KMC lease boundary) and would not exceed applicable USEPA screening levels. Arsenic background levels at both NGS and the proposed KMC exceed the human health screening levels. The evaluation of arsenic in the HHRA at a refined level (95 percent UCL) indicated that arsenic did not cause an unacceptable baseline cancer risk to human receptors of all types; the NGS contribution is small (5 percent), and would not change conclusion that the cancer risks were within acceptable USEPA levels (Section 3.16, Public Health).

3.6.4.3.5 Cumulative Impacts

3.6.4.3.5.1 Surface Disturbance/Erosion

The total estimated surface disturbance for past and present actions, proposed action, and reasonably foreseeable future actions is between 62,514 and 61,985 acres (**Table 3.0-1**). By 2044, assuming NGS and Kayenta Mine closure and demolition, up to 3,724 acres that includes the NGS plant site, railroad, and coal combustion residual landfill would require reapplication of soil materials and revegetation after demolition; a range of 9,000 to 10,000 acres of proposed KMC mined area and demolished surface facilities would require topsoiling and reseeding. No new revegetation actions would be required on transmission line ROWs because these ROWs are already vegetated, and would continue operations into the future. Reapplied soils to disturbed areas after 2044 would be protected under the same lease provisions, and bond release programs that existed prior to project termination

Approximately 4,200 acres of reasonably foreseeable surface disturbance from linear utility projects are included in the overall cumulative impact estimate. The TransWest Express, Southern Nevada Intertie, and Eastern Nevada transmission lines may be constructed in an existing West-Wide ROW adjacent to the WTS from the vicinity of Mesquite to the Eldorado Valley south of Las Vegas, Nevada (**Figure 3.0-3**). Segments of the Lake Powell water pipeline and transmission line are proposed to overlap with the WTS utility corridor in Coconino County, Arizona west of Lake Powell (**Figure 3.0-2**). All new surface disturbance would be subject to soil protection measures mandated in ROW conditions received from the BLM or Tribe.

The primary potential cumulative impacts to soils would be the overlapping use of existing access roads by construction and maintenance equipment for adjacent utility projects sharing the same broadly defined utility corridor. For example, the TransWest Express Plan of Development indicates it would use existing utility corridor roads with short spur roads for transmission line structure construction and operation. There could be some localized minor additional soil disturbance from WTS operation and maintenance activities, if the twice yearly inspections occur on the same access routes during periods of construction by these foreseeable projects. Any specific proposals to construct new projects and maintain existing facilities would be coordinated through the responsible BLM or other federal and tribal land management agency offices in Nevada and Arizona. Requirement for new roads, maintenance of existing roads, and repair of damaged roads would be developed on a project-specific basis. The net result would be reduced requirements for new access roads in a common utility corridor, which would reduce the risk of erosion and sedimentation from the road system.

The overall impact from all cumulative sources would be moderate because of the large overall area of disturbance that would require soil protection in accordance with ongoing required reclamation programs and best management practices.

3.6.4.3.5.2 Trace Metals Deposition

The cumulative impacts of trace metal emission and dispersion from coal combustion sources are addressed in Section 3.1. Based on NGS air quality modeling in both near-field (50 km from the source) and far-field (300 km for the source), the majority of the deposition occurs within 20 km of NGS. Proposed KMC modeling indicates the majority of particulate deposition within the proposed KMC lease boundary. As a consequence there are limited or no trace metal emission interactions of NGS or proposed KMC with other regional coal-fired generation sources. As described in 3.1 Air Quality, NGS metals deposition represents a minor cumulative impact addition to other existing and foreseeable regional emissions sources. The Proposed Action contribution represents 1.7 to 2.2 percent of the estimated cumulative total mercury deposition rate (12.7 micrograms per square meter per year) (Section 3.1, Subsection 3.1.4.3). This cumulative total mercury deposition rate compares with a northern Arizona regional background deposition rate of 10 to 15 micrograms per square meter (Butler et al. 2007).NGS emissions represent 0.44 percent of total selenium deposition.

Interactions among regional coal generation sources with global scale sources result in cumulative biological impacts resulting from mercury deposition on soils, transport to waterbodies via sediment, and uptake by aquatic organisms. The impacts of mercury in fish tissue were estimated through air quality and sediment transport modeling studies conducted by Electric Power Research Institute (Electric Power Research Institute 2016). The results from the Electric Power Research Institute study were included in the ERAs conducted for aquatic life (Section 3.12), and special status fish species (Section 3.13) to estimate cumulative impacts (**Tables 3.13-11** and **3.13-12**).

3.6.4.4 Natural Gas Partial Federal Replacement Alternative

Under the Natural Gas Partial Federal Replacement (PFR) Alternative, a selected quantity of power between 100 megawatts (MW) and 250 MW would be contracted for under a long-term power purchase agreement from currently unidentified, existing natural gas generation sources, displacing an equivalent amount of power from the federal share of NGS generation. Because the facility is assumed to currently exist, prior disturbance impacts to Soil Resources are not evaluated. Below is a list of key assumptions about soil resources related to such an existing site.

- A combined-cycle natural gas power plant would typically be located on a site of approximately 100 acres. No additional surface disturbance would be required over time.
- Soil would be removed from the entire site, and would not be replaced and revegetated until after facility decommissioning.

- Natural gas combustion for power generation would not result in COPEC emissions and deposition that would overlap with the coal combustion emissions and deposition from NGS; therefore, there would be no deposition from natural gas combustion to soil in the Study Area. The description of emission calculations for the PFR are described in Chapter 2.0 and in Section 3.1, Air Quality.

Impact issues for the Natural Gas PFR Alternative are discussed across the range of NGS unit operations (3-Unit and 2-Unit) and associated alternative power reductions (100 MW and 250 MW) from the least NGS power reduction to the greatest. Reductions in NGS power generation would proportionally reduce the quantity of coal delivered from the Kayenta Mine.

3.6.4.4.1 Navajo Generating Station

3.6.4.4.1.1 Surface Disturbance/Erosion

The following operational factors would limit additional surface disturbance and soil stabilization efforts across the operating range of this, and other PFR alternatives:

- Current soil protection and erosion control measures and coal combustion residual inspection requirements would prevent soil erosion losses from the coal combustion residual landfill (**Appendix 1B**, page 52 and 94);
- The plant site is required to comply with stormwater permit requirements, which require retention of stormwater and associated sediment to prevent offsite soil erosion; and
- No new surface disturbance would be required to operate the BM&LP Railroad.

Salvaged surface materials would be sufficient to provide the necessary cover for all coal combustion residuals volumes generated across the entire operating range of this PFR alternative over the entire 200 acre active area of the coal combustion residuals landfill through 2044.

There would be insufficient coal combustion residuals landfill capacity to accommodate coal combustion residuals volumes through 2044 under the proposed 3-Unit Operation, requiring an expansion of the existing 200 acre active to accommodate an additional 3.7 million cubic yards (**Appendix 1B**, page 54). Neither the 3-Unit 100-MW or the 3-Unit 250-MW Natural Gas PFR operation would reduce coal combustion residual volumes sufficiently to avoid this expansion, thereby requiring new surface disturbance of approximately 20 percent or 40 acres. There would be sufficient combustion residuals landfill capacity to accommodate coal combustion residuals volumes through 2044 under the 2-Unit 100-MW and 250-MW PFR operations, and therefore no new soil disturbance would be required for a landfill expansion.

Demolition would result in removal of most NGS surface facilities, and reapplication of soil or suitable surface materials, and restoration with native vegetation (**Appendix 1B**, pages 99-106). This demolition process is common to all PFR alternatives.

The impacts of these activities across the operating range of the Natural Gas PFR Alternative would be moderate (same as Proposed Action) because the surface disturbance (approximately 3,700 acres) remaining after demolition would be subject to existing intensive surface management programs for both site erosion control and sedimentation, and for maintenance of short- and long-term stability of revegetated land surface.

3.6.4.4.1.2 Trace Metals Deposition from NGS Stack Emissions

Selenium, arsenic and mercury for the Natural Gas PFR Alternative NGS stack emissions would be reduced relative to the Proposed Action as presented in **Table 3.6-8** below:

Table 3.6-8 Comparison of Trace Metal Emissions Under the Proposed Action and Natural Gas PFR Alternative

Trace Metal	NGS Operation	Proposed Action Emissions (tpy)	Natural Gas PFR 100-MW Power Reduction Emissions (tpy / % change)[1]	Natural Gas PFR 2500-MW Power Reduction Emissions (tpy / % change)[1]
Selenium	3-Unt	2.237	2.127 / -5%	1.957 / -13%
Selenium	2-Unit	1.491	1.377 / -8%	1.208 / -19%
Mercury (total)	3-Unit	0.117	0.111 / -5%	0.102 / -13%
Mercury (total)	2-Unit	0.078	0.072 / -8%	0.063 / -19%
Arsenic	3-Unit	0.133	0.127 / -5%	0.117 / -12%
Arsenic	2-Unit	0.089	0.083 / -7%	0.073 / -18%

[1] Percent change represents the percentage reduction when compared to the Proposed Action.

The impacts of 5 to 19 percent lower trace metal deposition from this alternative (relative to the Proposed Action) would be minor because Proposed Action air quality modeling indicates that estimated deposition rates of selenium and mercury, combined with background soil concentrations, would not exceed ERA and HHRA soil screening levels that indicate a concentration level of concern. Background levels of arsenic are above the USEPA human health screening level, but in combination with very small project deposition under all alternatives, would not cause an unacceptable cancer risk as documented by the HHRA (Section 3.16, Public Health).

3.6.4.4.2 Proposed Kayenta Mine Complex

3.6.4.4.2.1 Surface Disturbance/Erosion

Under this PFR alternative, all mining through the life-of-mine would occur within the proposed KMC. Vegetation clearing, topsoil removal, topsoil salvage (direct haul and stockpiling), and mining methods would continue as described for the existing operations (PWCC 2012 et seq.). Additional topsoil stockpiles and additional drainage and sediment control structures would be added as mining progresses (PWCC 2012 et seq.). Disturbed areas would be restored to approximate landforms that existed prior to mining and would support vegetation similar to surrounding areas. As discussed previously, reclamation procedures will create a suitable 4-foot thick plant root zone over the entire reclaimed area and establish a diverse and permanent vegetation cover. All surface disturbance is subject to a soil stabilization and revegetation adequacy standard prior to release back to the surface owner, the Navajo Nation or Hopi Tribe.

Mining surface disturbance under this PFR alternative would be proportionally reduced as illustrated in **Table 3.0-7**. It is recognized that actual surface disturbance may not be directly proportional to coal mined because of differences in overburden and coal seam thickness across the coal resource areas.

The impacts of surface coal mining would be moderate because approximately 3,888 to 4,968 acres of new surface disturbance at risk for soil erosion are subject to existing intensive surface management programs for soil salvage, soil erosion control, sedimentation control, and revegetation (**Appendix 1D**). It is anticipated that approximately 9,000 to 10,000 acres of surface disturbance (coal mining areas and surface facilities) would remain for topsoil material application and revegetation by 2044.

peak mining years, and proximity of mining to downwind residential receptors. Because of the multiple variables included in modeling, the results cannot be proportionally scaled from one mining scenario to a lower one without further detailed modeling. To provide perspective, the deposition rates of trace metals were compared with the concentrations of arsenic, mercury, and selenium in Kayenta Mine soils and coal that were used for input to the ERA and HHRAs. Selenium and mercury background concentrations were below USEPA screening levels, and deposition rates of these metals would be less than 5 percent of the background levels.

Impacts from the deposition of trace metals contained in particulate matter originating from mining activities would be minor because estimated deposition rates of selenium and mercury, combined with background soil concentrations, would not exceed ERA and HHRA soil screening levels that indicate a concentration level of concern. Background levels of arsenic are above the USEPA human health screening level, but in combination with very small project deposition contribution under this PFR alternative, would not cause an unacceptable cancer risk as documented by the HHRA (Section 3.16, Public Health).

3.6.4.4.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

3.6.4.4.4 Project Impact Summary – All Project Components

The combined new soil disturbance at NGS and at proposed KMC under the Natural Gas PFR Alternative would range from a high of 5,265 to a low of 4,145 acres. This soil disturbance compares to a Proposed Action range of 5,527 acres to a low of 4,998 acres, or an overall 5 to 18 percent reduction in new land disturbance for this PFR alternative. Soil protection, and erosion and sediment control programs, and transmission line and communication site operation and maintenance activities would be the same as those for the Proposed Action. The impacts of new soil disturbance of this PFR would be moderate (same as the Proposed Action) because of the large scale (greater than 4000 acres) of new surface disturbance that would be stabilized by soil protection and revegetation measures mandated by federal and tribal agencies, and the requirement to apply soil materials and initiate revegetation after NGS decommissioning, and KMC closure in 2044 to approximately 9,000 to 10,000 acres.

Deposition of trace metals to soil from NGS and proposed KMC would be slightly less for this PFR than for the Proposed Action. The impacts of trace metals deposition would be minor (same as the Proposed Action) because the estimated selenium and mercury deposition concentrations, combined with background soil concentrations, would not exceed USEPA screening level standards for soil. Arsenic background concentrations are above the screening level at both NGS and proposed KMC; arsenic deposition from NGS and Kayenta Mine operations are very low. The combined concentrations from these sources would not cause an unacceptable cancer risk as documented by the HHRA (Section 3.16, Public Health).

3.6.4.4.5 Cumulative Impacts

3.6.4.4.5.1 Surface Disturbance/Erosion

The cumulative impacts of surface disturbance would be 1 percent less than those estimated for the Proposed Action. The surface disturbance contributed by this PFR alternative, past and present actions and foreseeable actions is estimated to be between 61,132 and 62,252 acres, of which approximately 3,624 acres at NGS, coal combustion residual landfill and railroad would require topsoil material reapplication and revegetation after demolition, and a range of 9,000 to 10,000 acres of mined land and surface facilities would remain to be reclaimed at the proposed KMC after 2044. An additional 4,201 acres of surface disturbance resulting from construction of foreseeable actions (transmission lines and water pipelines) would be topsoiled and reseeded in the near-term (assumed to be by 2025).

3.6.4.4.5.2 Trace Metal Deposition

The deposition to soils of selenium, arsenic, and mercury contained in stack emissions and particulate matter from both NGS and the proposed KMC under this PFR alternative (see Project Summary) would continue over a 24 year period primarily within a 20-km to 50-km radius of each facility and would not overlap with deposition from other existing coal combustion sources, or other foreseeable actions with the exception of mercury, which would add a small increment to existing regional and global sources. Based on emission rates for the Proposed Action, this alternative would reduce the NGS emissions contribution by 5 to 19 percent (**Table 3.6-8**).

3.6.4.5 Renewable Partial Federal Replacement Alternative

Under the Renewable PFR Alternative, a selected quantity of power between 100 MW and 250 MW would be contracted for under a long-term power purchase agreement from a currently unidentified, existing renewable energy power source, displacing an equivalent amount of power from the federal share of NGS generation. Because the facility is assumed to currently exist, prior disturbance impacts to Soil Resources are not evaluated. The following are key assumptions about soil resources related to such an existing site:

- A renewable energy generation facility (assumed to be photovoltaic) would typically be located on a site up to 3,000 acres. No additional surface disturbance would be required over time.
- Soil would be removed from the entire site, and would not be replaced and revegetated until after facility decommissioning.
- Photovoltaic panels that generate electrical energy would not cause deposition to soil of the trace metal associated with coal combustion under the Proposed Action. This difference in emissions is addressed in the Air Quality resource section.

Impact issues for this PFR alternative are discussed across the range of NGS unit operations (3-Unit and 2-Unit) and associated alternative power reductions (100 MW and 250 MW) from the least NGS power reduction to the greatest. Reductions in NGS power generation would proportionally reduce the quantity of coal delivered from the Kayenta Mine.

3.6.4.5.1 Navajo Generating Station

3.6.4.5.1.1 Surface Disturbance/Erosion

Operational factors would limit additional surface disturbance and soil stabilization efforts across the operating range of this, and other PFR alternatives.

- Current soil protection and erosion control measures and coal combustion residual inspection requirements would prevent soil erosion losses from the coal combustion residual landfill (**Appendix 1B**, pages 52 and 94).
- The plant site is required to comply with storm water permit requirements, which require retention of storm water and associated sediment to prevent offsite soil erosion.
- No new surface disturbance would be required to operate the BM&LP Railroad.

Salvaged surface materials would be sufficient to provide the necessary cover for all coal combustion residuals volumes generated across the entire operating range of this PFR alternative over the entire 200 acre active area of the coal combustion residuals landfill through 2044. The requirements for coal combustion residual landfill cover would be the same as those described for the Natural Gas PFR Alternative.

The impacts of these activities across the operating range of this PFR alternative would be moderate (same as Proposed Action) because the surface disturbance (approximately 3,624 acres) remaining after demolition would be subject to existing intensive surface management programs for both site erosion control and sedimentation, and for maintenance of short- and long-term stability of revegetated land surface.

3.6.4.5.1.2 Trace Metals Deposition from NGS Stack Emissions

Selenium, arsenic and mercury for PFR NGS stack emissions would be reduced relative to the Proposed Action as presented in **Table 3.6-9** below:

Table 3.6-9 Comparison of Trace Metal Emissions Under the Proposed Action and Renewable PFR Alternative

Trace Metals	NGS Operation	Proposed Action Emissions (tpy)	Renewable PFR 100-MW Power Reduction (tpy / % change)[1]	Renewable PFR 250-MW Power Reduction (tpy / % change)[1]
Selenium	3-Unt	2.237	2.174 / -3%	2.075 / -7%
Selenium	2-Unit	1.491	1.424 / -4%	1.325 / -11%
Mercury (total)	3-Unit	0.117	0.114 / -5%	0.108 / -8%
Mercury (total)	2-Unit	0.078	0.075 / -4%	0.069 / -12%
Arsenic	3-Unit	0.133	0.130 / -2%	0.124 / -7%
Arsenic	2-Unit	0.089	0.086 / -3%	0.080 / -10%

[1] Percent change represents the percentage reduction when compared to the Proposed Action.

The 3-Unit 100-MW and 250-MW PFR operations would result in emissions of approximately 2 to 8 percent less selenium, arsenic, and mercury than the 3-Unit Proposed Action; the 2-Unit 100-MW and 250-MW PFR operations would result in emissions of approximately 3 to 12 percent less for the same metals.

The impacts of 2 to 12 percent lower trace metal deposition from this alternative (relative to the Proposed Action) would be minor because Proposed Action air quality modeling indicates that estimated deposition rates of selenium and mercury, combined with background soil concentrations, would not exceed ERA and HHRA soil screening levels that indicate a concentration level of concern. Background levels of arsenic are above the USEPA human health screening level, but in combination with very small project deposition under all alternatives, would not cause an unacceptable cancer risk as documented by the HHRA (Section 3.16, Public Health).

3.6.4.5.2 Proposed Kayenta Mine Complex

3.6.4.5.2.1 Surface Disturbance/Erosion

Under this PFR alternative, all mining through the life-of-mine would occur within the proposed KMC. Vegetation clearing, topsoil removal, topsoil salvage (direct haul and stockpiling), and mining methods would continue as described for the existing operations (PWCC 2012 et seq.). Additional topsoil stockpiles and additional drainage and sediment control structures would be added as mining progresses (PWCC 2012 et seq.). Disturbed areas would be restored to approximate landforms that existed prior to mining and would support vegetation similar to surrounding areas. As discussed previously, reclamation procedures will create a suitable 4-foot thick plant root zone over the entire reclaimed area and establish a diverse and permanent vegetation cover. All surface disturbance is subject to a soil stabilization and revegetation adequacy standard prior to release back to the surface owner, the Navajo Nation or Hopi Tribe.

Mining surface disturbance under this PFR alternative would be proportionally reduced as illustrated in **Table 3.0-7**. It is recognized that actual surface disturbance may not be directly proportional to coal mined because of differences in overburden and coal seam thickness across the coal resource areas.

The impacts of surface coal mining would be moderate because approximately 5,072 to 4,267 acres of new surface disturbance at risk for soil erosion are subject to existing intensive surface management programs for soil salvage, soil erosion control, sedimentation control, and revegetation (**Appendix 1D**). It is estimated that 9,000 to 10,000 acres of surface disturbance (mine areas, surface facilities) would remain for reclamation in 2044.

3.6.4.5.2.2 Trace Metal Deposition from Suspended Particulates (Dust)

See the Natural Gas PFR Alternative for impact assumptions. Based on Proposed Action estimates, impacts from the deposition of trace metals contained in particulate matter originating from mining activities would be less than the Proposed Action, and minor because estimated deposition rates of selenium and mercury, combined with background soil concentrations, would not exceed ERA and HHRA soil screening levels that indicate a concentration level of concern. Background levels of arsenic are above the USEPA human health screening level, but in combination with very small project deposition contribution under this PFR alternative, would not cause an unacceptable cancer risk as documented by the HHRA (Section 3.16, Public Health).

3.6.4.5.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

3.6.4.5.4 Project Impact Summary – All Project Components

The combined new soil disturbance at NGS and at proposed KMC under the Renewable PFR would range from a high of 5,072 to a low of 4,267 acres. This soil disturbance compares to a Proposed Action range of 5,230 acres to a low of 4,741 acres, or an overall 3 to 10 percent reduction in new land disturbance for this PFR alternative. Soil protection, and erosion and sediment control programs, and transmission line and communication site operation and maintenance activities would be the same as those for the Proposed Action. The impacts of new soil disturbance of this PFR would be moderate (same as the Proposed Action) because of the large scale (greater than 4,000 acres) of new surface disturbance that would be stabilized by soil protection and revegetation measures mandated by federal and tribal agencies, and the requirement to apply soil materials and initiate revegetation after NGS decommissioning, and KMC closure in 2044 to approximately 9,000 to 10,000 acres.

Deposition of trace metals to soil from NGS and proposed KMC would be slightly less (**Table 3.6-10**) for this PFR than for the Proposed Action. The impacts of trace metals deposition would be minor (same as the Proposed Action) because deposition concentrations would not exceed USEPA protective screening criteria for soils.

3.6.4.5.5 Cumulative Impacts

3.6.4.5.5.1 Surface Disturbance/Erosion

The cumulative impacts of surface disturbance would be less than one percent of those estimated for the Proposed Action. The scale and location of surface disturbance would be nearly the same as that described for the Natural Gas PFR Alternative.

3.6.4.5.5.2 Trace Metal Deposition

The deposition to soils of selenium, arsenic, and mercury contained in stack emissions and particulate matter from both NGS and the Kayenta Mine under this PFR alternative (see Project Summary) would continue over a 24-year period primarily within a 20-km to 50-km radius of each facility and would not overlap with deposition from other existing coal combustion sources, or other foreseeable actions with the exception of mercury, which would add a very small increment to existing regional and global sources. Based on emission rates for the Proposed Action, this alternative would reduce the NGS emissions contribution by 2 to 12 percent (**Table 3.6-9**).

3.6.4.6 Tribal Partial Federal Replacement Alternative

Under the Tribal PFR Alternative, between 100 MW and 250 MW of power generation from the NGS would be replaced by power supplied by a new photovoltaic generation facility on tribal land, displacing an equivalent amount of power from the federal share of NGS generation. The construction of a new photovoltaic generation site on tribal land would result in between 1,200 and 3,000 acres of new surface disturbance. The Tribal PFR facility would be analyzed in a separate NEPA process once a facility location is identified. Key assumptions about soil resources related to such a site are listed below:

- A renewable energy generation facility (assumed to be photovoltaic) would typically be located on a site of approximately of 1,200 to 3,000 acres to meet the requirement to provide 100 MW to 250 MW. This estimate includes an interconnecting transmission line of 5 miles, with a 100-foot ROW.
- The site would be located on an upland, level site. Intermittent or perennial drainage channels would be avoided during site selection. The possible major soil units where the project would be located include Land Resource Area 35 (Colorado Plateau), and Land Resource Area 40 (Sonoran Basin and Range). An overview of these Land Resource Areas is provided in Section 3.6.3. In general, the soils are expected to be generally shallow, with very limited horizon development because of the arid climate. Soil would be removed from the entire site, and would not be replaced and revegetated until after facility decommissioning.
- Natural gas firming power would not result in trace metal emissions deposition that would overlap with the associated with coal combustion emissions and deposition from NGS under the Proposed Action; therefore, there would be no deposition from the natural gas combustion to soil in the Study Area. The emissions caused from construction of the solar facility (fugitive dust and vehicle exhaust) could be located in the NGS and KMC study areas but would be very localized and temporary, and therefore, considered to have no effect on soil resources and not carried forward in the analysis. This description of emission calculations for the PFR are described in Chapter 2.0 and in Section 3.1, Air Quality.

Impact issues for this PFR alternative are discussed across the range of NGS unit operations (3-Unit and 2-Unit) and associated alternative power reductions (100 MW and 250 MW) from the least NGS power reduction to the greatest. Reductions in NGS power generation would proportionally reduce the quantity of coal delivered from the Kayenta Mine.

3.6.4.6.1 Navajo Generating Station

3.6.4.6.1.1 Surface Disturbance/Erosion

Surface disturbance and soil stabilization management practices would be the same as those described for the Natural Gas PFR Alternative.

Salvaged surface materials would be sufficient to provide the necessary cover for all coal combustion residuals volumes generated across the entire operating range of this PFR alternative over the entire 200 acre active area of the coal combustion residuals landfill through 2044. The requirements for coal combustion residual landfill cover would be the same as those described for the Natural Gas PFR Alternative.

The impacts of these activities across the operating range of this PFR alternative would be moderate (same as Proposed Action) because the surface disturbance (approximately 3,624 acres) remaining after demolition would be subject to existing intensive surface management programs for both site erosion control and sedimentation, and for maintenance of short- and long-term stability of revegetated land surface.

3.6.4.6.1.2 Trace Metals Deposition from NGS Stack Emissions

Selenium, arsenic and mercury for PFR NGS stack emissions would be reduced relative to the Proposed Action as presented in **Table 3.6-10** below:

Table 3.6-10 Comparison of Trace Metal Emissions Under the Proposed Action and Tribal PFR Alternative

Trace Metal	NGS Operation	Proposed Action Emissions (tpy)	Tribal PFR 100-MW Power Reduction Emissions (tpy / % change)[1]	Tribal PFR 250-MW Power Reduction Emissions (tpy / % change)[1]
Selenium	3-Unt	2.237	2.174 / -3%	2.123 / -5%
Selenium	2-Unit	1.491	1.424 / -4%	1.325 / -11%
Mercury (total)	3-Unit	0.117	0.114 / -3%	0.111 / -5%
Mercury (total)	2-Unit	0.078	0.076 / -3%	0.072 / -8%
Arsenic	3-Unit	0.133	0.130 / -2%	0.127 / -5%
Arsenic	2-Unit	0.089	0.087 / -2%	0.083 / -7%

[1] Percent change represents the percentage reduction when compared to the Proposed Action.

The 3-Unit 100-MW and 250-MW PFR operations would result in emissions of approximately 2 to 5 percent less selenium, arsenic, and mercury than the 3-Unit Proposed Action; the 2-Unit 100-MW and 250-MW PFR operations would result in emissions of approximately 2 to 11 percent less for the same metals.

The impacts of 2 to 11 percent lower trace metal deposition from this alternative (relative to the Proposed Action) would be minor because Proposed Action air quality modeling indicates that estimated deposition rates of selenium and mercury, combined with background soil concentrations, would not exceed ERA and HHRA soil screening levels that indicate a concentration level of concern. Background levels of arsenic are above the USEPA human health screening level, but in combination with very small project deposition under all alternatives, would not cause an unacceptable cancer risk as documented by the HHRA (Section 3.16, Public Health).

3.6.4.6.2 Proposed Kayenta Mine Complex

3.6.4.6.2.1 Surface Disturbance/Erosion

In accordance with the Kayenta Mine life-of-mine plan, continued coal surface mining requires that soil materials be salvaged and protected by excavating soils to an approved depth, and then stockpiled. Based on chemical and physical characteristics, stockpiled soil materials are mixed with suitable overburden to achieve a growth medium suitable for revegetation. Erosion control and sedimentation structures are placed downslope from disturbed areas, limiting the movement of soil and sediment away from active mining areas (**Appendix 1D**). Under this PFR Alternative, all mining through the life-of-mine would occur within the proposed KMC. Vegetation clearing, topsoil removal, topsoil salvage (direct haul and stockpiling), and mining methods would continue as described for the existing operations (PWCC 2012 et seq.). Additional topsoil stockpiles and additional drainage and sediment control structures would be added as mining progresses (PWCC 2012 et seq.). Disturbed areas would be restored to approximate landforms that existed prior to mining and would support vegetation similar to surrounding areas. As discussed previously, reclamation procedures will create a suitable 4-foot thick plant root zone over the entire reclaimed area and establish a diverse and permanent vegetation cover. All surface disturbance is subject to a soil stabilization and revegetation adequacy standard prior to release back to the surface owner, the Navajo Nation or Hopi Tribe.

Mining surface disturbance under this PFR alternative would be proportionally reduced as illustrated in **Table 3.0-7**. It is recognized that actual surface disturbance may not be directly proportional to coal mined because of differences in overburden and coal seam thickness across the coal resource areas.

The impacts of surface coal mining would be moderate because approximately 5,124 to 4,409 acres of new surface disturbance at risk for soil erosion are subject to existing intensive surface management programs for soil salvage, soil erosion control, sedimentation control, and revegetation (**Appendix 1D**). It is estimated that 9,000 to 10,000 acres of surface disturbance (mine areas, surface facilities) would remain for reclamation in 2044.

3.6.4.6.2.2 Trace Metal Deposition from Suspended Particulates (Dust)

See the Natural Gas PFR Alternative for impact assumptions. Based on Proposed Action estimates, impacts from the deposition of trace metals contained in particulate matter originating from mining activities would be less than the Proposed Action, and minor because estimated deposition rates of selenium and mercury, combined with background soil concentrations, would not exceed ERA and HHRA soil screening levels that indicate a concentration level of concern. Background levels of arsenic are above the USEPA human health screening level, but in combination with very small project deposition contribution under this PFR alternative, would not cause an unacceptable cancer risk as documented by the HHRA (Section 3.16, Public Health).

3.6.4.6.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

3.6.4.6.4 Project Impact Summary – All Project Components

The combined new soil disturbance at NGS and at proposed KMC under the Renewable PFR would range from a high of 5,124 to a low of 4,409 acres. This soil disturbance compares to a Proposed Action range of 5,230 acres to a low of 4,741 acres, or an overall 2 to 7 percent reduction in new land disturbance for this PFR alternative. Soil protection, and erosion and sediment control programs, and transmission line and communication site operation and maintenance activities would be the same as those for the Proposed Action. The impacts of new soil disturbance of this PFR would be moderate (same as the Proposed Action) because of the large scale (greater than 4,000 acres) of new surface disturbance that would be stabilized by soil protection and revegetation measures mandated by federal and tribal agencies. In addition, from 1,200 to 3,000 additional acres would be disturbed to construct a new photovoltaic generation facility and interconnecting transmission line. Decommissioning of these same areas would be required at the end of the photovoltaic facility life. It is assumed that standard soil salvage and protection measures would be implemented in compliance with National Environmental Policy Act Record of Decision conditions, and lease agreements.

Deposition of trace metals to soil from NGS and proposed KMC would be slightly less for this PFR than for the Proposed Action. The impacts of trace metals deposition would be minor (same as the Proposed Action) because deposition concentrations would not exceed USEPA protective screening criteria for soils.

3.6.4.6.5 Cumulative Impacts

3.6.4.6.5.1 Surface Disturbance/Erosion

The maximum cumulative impacts of surface disturbance (including a new photovoltaic facility ranging in size from 1,200 to 3,000 acres) would be approximately 5 percent more than those estimated for the Proposed Action (3-Unit Operation). Approximately 4,201 acres would result from construction of new transmission lines and water pipelines in the WTS corridor in Arizona, Utah, and Nevada. All identified new soil disturbance would be subject to soil stripping, salvage, and reapplication measures administered by a responsible federal agency.

3.6.4.6.5.2 Trace Metal Deposition

The deposition to soils of selenium, arsenic, and mercury contained in stack emissions and particulate matter from both NGS and the Kayenta Mine under this PFR alternative (see Project Summary) would continue over a 24 year period primarily within a 20 to 50 km radius of each facility and would not overlap with deposition from other existing coal combustion sources, or other foreseeable actions with the exception of mercury, which would add a small increment to existing regional and global sources. Based on emission rates for the Proposed Action, this alternative would reduce the NGS emissions contribution by 3 to 11 percent (**Table 3.6-10**).

3.6.4.7 No Action

3.6.4.7.1 Navajo Generating Station

3.6.4.7.1.1 Surface Disturbance/Erosion

If continued operation of the NGS and the BM&LP Railroad is not approved, the power plant, associated facilities, and the BM&LP Railroad would be decommissioned as described above in the Proposed Action. Management of soils would be the same as described for the Proposed Action. Approximately 3,624 acres would require soil material application and reseeding. This number of acres assumes that 100 acres of facilities would be turned over to the Navajo Nation, and would not be decommissioned.

3.6.4.7.1.2 Trace Metal Deposition from NGS Stack Emissions

Trace metal deposition from NGS stacks would cease after 2018. Soil surface concentrations of selenium, mercury, and arsenic would similar to the concentrations measured from baseline soil sampling programs completed in 2014 (**Table 3.6-2**). Ecological and HHRAs were conducted for near-field baseline (No Action) conditions, based on this recent soil sampling. Refined HQs for all of the terrestrial wildlife and vegetation receptors were less than 1 for all COPECs for baseline conditions within the NGS Near-field study area, indicating that risks to terrestrial communities from baseline conditions (including exposure to soils) are negligible (Section 3.10). The baseline HHRA found that all cancer and non-cancer risks (including lead) were in the acceptable range in relation to USEPA and Center for Disease Control criteria. Fugitive dust generation would occur during decommissioning activities, which would be completed by 2020.

3.6.4.7.2 Proposed Kayenta Mine Complex

3.6.4.7.2.1 Surface Disturbance/Erosion

If the continued operation at the proposed KMC is not approved, all disturbed lands that exist in 2019 would be regraded, and a suitable mixture of soil and overburden would be applied in accordance with existing programs overseen by OSMRE. Approximately 5,230 acres would be disturbed if mining ceased in 2019 than under the Proposed Action.

3.6.4.7.2.2 Trace Metal Deposition from Suspended Particulates (Dust)

Refined HQs for all of the terrestrial wildlife and vegetation receptors were less than 1 for all COPECs for baseline (No Action) conditions within the KMC study area, indicating that risks to terrestrial communities from baseline conditions (including exposure to soils) are negligible (Section 3.8, Vegetation, Section 3.10, Terrestrial Wildlife).

Based on the cancer risk estimates, non-cancer and target organ analysis hazard indexes, and the separate evaluation for blood lead in children, there were no unacceptable human health risks identified for the baseline (No Action) risk case. Because all baseline human health risks were considered acceptable, negligible impact on human health was identified in the vicinity of the proposed KMC (Section 3.16, Public Health).

3.6.4.7.3 Transmission Systems and Communication Sites

The NGS transmission system is an established part of the western U.S. transmission grid and supports reliability and delivery of power throughout the region, well beyond the power generated by the NGS. Therefore, under the No Action Alternative it is likely that that one, several, or all of the land owners/managers of the transmission line rights-of-way and communication site leases would renew some portion of the facilities to keep the power grid performing as expected.

In the event it is determined that some or all of the transmission systems and communication site ROWs are not renewed, a lengthy study and permitting process would need to occur before any decommissioning is initiated due to the essential and integral nature of these facilities with the western electric grid. Based on the assumptions presented in Section 2.3.3, an estimated 4,826 acres could be temporarily disturbed if the entirety of the transmission systems and communication sites were decommissioned and removed.

Only after it is determined which facilities would be decommissioned, replaced and/or would remain can the specific areas that would be disturbed by decommissioning activities be identified. Subsequent NEPA compliance would be initiated once these plans are completed.

3.6.4.7.4 No Action Impact Summary – All Project Components

The decommissioning activities at NGs and the reclamation at KMC would be the same as those described for the Proposed Action except that these activities would be initiated starting in 2018. Total project reclamation requirements are estimated to be 9,272 acres (**Table 3.0-2**). NGS decommissioning would be completed in 2020; reclamation at KMC would occur over a 5 to 10 year time frame (and possibly longer depending on revegetation success).

As described for the individual project components, near-field NGS stack emissions and KMC fugitive dust emissions from mining would cease in 2018. Trace metal concentrations in soils are expected to remain similar to the concentrations of these components measured from field sampling in 2014. Local fugitive dust emissions and deposition would continue during decommissioning activities that are expected to conclude in 2020 at NGS, and over a 10-year period or longer at KMC. The baseline (No Action) risks to ecological and human health are expected to remain negligible over time because there would be a net reduction in pollutant emissions when both sources cease operations.

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Section 3.7

Water Resources

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Acronyms and Abbreviations

µg/L	micrograms per liter
1969 Lease	Navajo Project Indenture of Lease
amsl	above mean sea level
BART	Best Available Retrofit Technology
bgs	below ground surface
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BM&LP Railroad	Black Mesa & Lake Powell Railroad
BO	Biological Opinion
CAP	Central Arizona Project
CCR	Coal Combustion Residual
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet per second
CO_2	carbon dioxide
Co-tenants	Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
Development Fund	Lower Colorado River Basin Development Fund
EIS	Environmental Impact Statement
ERA	Ecological Risk Assessment
ESA	Endangered Species Act of 1973
gpd	gallons per day
gpm	gallons per minute
HHRA	Human Health Risk Assessment
km	kilometer
KMC	Kayenta Mine Complex
kV	kilovolt
kW	kilowatt
mg/L	milligrams per liter
MW	megawatt
NAV	N-Aquifer well (PWCC)
NEPA	National Environmental Policy Act of 1969, as amended
NGS	Navajo Generating Station
NGS Participants	U.S. (Reclamation), Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
NHPA	National Historic Preservation Act
NPDES	National Pollutant Discharge Elimination System
NNEPA	Navajo Nation Environmental Protection Agency
NO_2	nitrogen dioxide

NO_X	nitrogen oxide
NSPG	Native Spring (PWCC)
OSMRE	Office of Surface Mining Reclamation and Enforcement
PAP	Permit Application Package (PWCC and OSMRE)
PFR	Partial Federal Replacement
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 microns or less
PWCC	Peabody Western Coal Company
Reclamation	U.S. Bureau of Reclamation
ROW	Right-of-way
SDWA	Safe Drinking Water Act
SO_2	sulfur dioxide
SPCC Plan	Spill Prevention, Control, and Countermeasure Plan
SRP	Salt River Project Agricultural Improvement and Power District
STS	Southern Transmission System
TDS	Total Dissolved Solids
tpy	tons per year
TSS	Total Suspended Solids
U.S.	United States
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
WTS	Western Transmission System

Contents

3.7 Water Resources ... 3.7-1
3.7.1 Regulatory Framework ... 3.7-1
3.7.1.1 Navajo Generating Station ... 3.7-1
3.7.1.2 Proposed Kayenta Mine Complex ... 3.7-2
3.7.1.3 Tribal Water Quality Standards ... 3.7-4
3.7.1.4 Transmission Systems and Communication Sites ... 3.7-5
3.7.2 Study Areas ... 3.7-5
3.7.2.1 Navajo Generating Station ... 3.7-9
3.7.2.2 Proposed Kayenta Mine Complex ... 3.7-9
3.7.2.3 Transmission Systems and Communication Sites ... 3.7-9
3.7.3 Affected Environment ... 3.7-9
3.7.3.1 Regional Overview ... 3.7-9
3.7.3.2 Navajo Generating Station ... 3.7-15
3.7.3.3 Proposed Kayenta Mine Complex ... 3.7-20
3.7.3.4 Transmission Systems and Communication Sites ... 3.7-41
3.7.4 Environmental Consequences ... 3.7-42
3.7.4.1 Issues, Assumptions, and Impact Methodology ... 3.7-42
3.7.4.2 Proposed Action ... 3.7-44
3.7.4.3 Natural Gas Partial Federal Replacement Alternative ... 3.7-116
3.7.4.4 Renewable Partial Federal Replacement Alternative ... 3.7-122
3.7.4.5 Tribal Partial Federal Replacement Alternative ... 3.7-127
3.7.4.6 No Action ... 3.7-131
3.7.5 References ... 3.7-139

List of Appendices

Appendix WR-1 - Stream Water Quality Characterizations

Appendix WR-2 - Pond Water Quality Characterizations PWCC Leasehold

Appendix WR-3 - Spring Flows and Water Quality PWCC Leasehold

Appendix WR-4 - Alluvial Groundwater Quality Characterizations PWCC Leasehold

Appendix WR-5 - Wepo Formation Groundwater Levels and Water Quality PWCC Leasehold

Appendix WR-6 - Additional Hydrogeology of Bedrock Units PWCC Leasehold and Surrounding Groundwater Study Area

Appendix WR-7 - N-Aquifer Pumping and Water Quality PWCC Leasehold

Appendix WR-8 - Cumulative Water Resources Supplemental Information

Appendix WR-9 - Groundwater Flow Modeling of the D- and N-Aquifers

Appendix WR-10 - U.S. Geological Survey Project Report

List of Tables

Table 3.7-1 Regulatory Programs for NGS Water Management ... 3.7-2
Table 3.7-2 Regulatory Programs for Kayenta Mine Water Management ... 3.7-2
Table 3.7-3 Average Monthly Precipitation at Selected Stations ... 3.7-10
Table 3.7-4 Lake Powell Magnitudes ... 3.7-14
Table 3.7-5 Deep Monitoring Wells at NGS ... 3.7-17
Table 3.7-6 NGS Unit Hydraulic Conductivities ... 3.7-17
Table 3.7-7 Average USGS Water and Lakebed Concentrations for Selected Constituents, Lake Powell and Selected Tributaries ... 3.7-22
Table 3.7-8 PWCC 2014 Well Withdrawals ... 3.7-25
Table 3.7-9 D-Aquifer Hydraulic Conductivity ... 3.7-27
Table 3.7-10 D-Aquifer Water Quality ... 3.7-29
Table 3.7-11 General Alluvial Groundwater Quality Characteristics ... 3.7-36
Table 3.7-12 Peak Flows at Current PWCC Streamflow Gages ... 3.7-39
Table 3.7-13 Anticipated N-Aquifer Withdrawals for the Proposed KMC Operations ... 3.7-50
Table 3.7-14 Maximum Drawdown at Key Community Production Wells from Mine-Related Proposed Action Pumping ... 3.7-53
Table 3.7-15 Percent Increase in Lift at Key Community Production Wells from Mine-Related Proposed Action Pumping ... 3.7-54
Table 3.7-16 Estimated Change in Sulfate Concentration at the End of 2110 Caused by the Proposed Action Pumping ... 3.7-55
Table 3.7-17 Simulated Baseflow 1956 Compared to the End of 2019 and Predicted Project Effects 2020 through 2110 ... 3.7-57
Table 3.7-18 Spring Groups Developed for Discussion Purposes ... 3.7-61
Table 3.7-19 PWCC Model Calibration Springs ... 3.7-61
Table 3.7-20 Maximum Impact at Non-Monitored Springs Due to Mine-Related Pumping, Proposed Action [1] ... 3.7-62
Table 3.7-21 Status and Numbers of Ponds and Impoundments, Proposed KMC ... 3.7-77
Table 3.7-22 Projected Runoff Effects of Structural Management Practices, 2019 Background ... 3.7-78
Table 3.7-23 Estimated Average Annual Leasehold Runoff Modifications at the End of Mining, 3-Unit Operation ... 3.7-79
Table 3.7-24 Estimated Average Annual Leasehold Runoff Modifications at the End of Mining, 2-Unit Operation ... 3.7-79
Table 3.7-25 Estimated Average Annual Leasehold Runoff Modifications after Post-mining Reclamation, 3-Unit Operation and 2-Unit Operation ... 3.7-80
Table 3.7-26 Cumulative Effects with Proposed Action 3-Unit Operation Withdrawals on Lake Powell Extent and Depth ... 3.7-93
Table 3.7-27 Cumulative Effects with Proposed Action 2-Unit Operation Withdrawals on Lake Powell Extent and Depth ... 3.7-94

Table 3.7-28 Community N-Aquifer Water Demands 2011 and 2110 ....3.7-98
Table 3.7-29 Maximum Increase in Lift Due to Proposed Mine-Related Pumping During Combined Pumping Activities 3.7-101
Table 3.7-30 PWCC Model Simulated Spring Flow Cumulative Pumping Effects 2019 compared to 2110....3.7-103
Table 3.7-31 Simulated Baseflow End of 2019 Compared to 2110 Cumulative Pumping Effects (Combined Community and Proposed PWCC Pumping)....3.7-105
Table 3.7-32 Predicted Sulfate Concentration and Percentage Change due to All Combined Pumping (Community and Mine-Related) through 2110 ....3.7-106
Table 3.7-33 Major Water Quality Changes in Long-term Alluvial Groundwater Monitoring....3.7-110
Table 3.7-34 Moenkopi Wash Long-term Water Quality Comparisons, Upstream to Downstream within the Leasehold....3.7-113
Table 3.7-35 Dinnebito Wash Long-term Water Quality Comparisons, Upstream to Downstream within the Leasehold....3.7-115
Table 3.7-36 Estimated Direct Effects of Natural Gas PFR Water Withdrawals on Lake Powell ...3.7-118
Table 3.7-37 Proposed KMC Surface Disturbance Estimates, Proposed Action Compared to the Natural Gas PFR Alternative....3.7-119
Table 3.7-38 Estimated Cumulative Effects of Natural Gas PFR Water Withdrawals and Lake Powell Pipeline Project on Lake Powell....3.7-121
Table 3.7-39 Proposed KMC Surface Disturbance Estimates, Proposed Action Compared to the Renewable PFR Alternative....3.7-124
Table 3.7-40 Proposed KMC Surface Disturbance Estimates, Proposed Action Compared to the Tribal PFR Alternative 3.7-129
Table 3.7-41 N-Aquifer Water Level Change from 2019 to 2057, Community and PWCC Effects, No Action Alternative....3.7-134
Table 3.7-42 No Action Alternative, 2019-2057 Percent Increase in N-Aquifer Lift at Key Community Production Wells due to PWCC Pumping 3.7-135

List of Figures

Figure 3.7-1 Water Resources Overall Study Areas 3.7-6
Figure 3.7-2 N-Aquifer Groundwater Study Area 3.7-7
Figure 3.7-3 N-Aquifer Surface Water Study Area 3.7-8
Figure 3.7-4 General Aquifer Relationships 3.7-11
Figure 3.7-5 Stratigraphy at NGS 3.7-16
Figure 3.7-6 Selected USGS Water Quality Sample Locations 3.7-21
Figure 3.7-7 N-Aquifer Transmissivities 3.7-24
Figure 3.7-8 D-Aquifer Water Quality Wells 3.7-28
Figure 3.7-9 Wepo Aquifer Transmissivities 3.7-31
Figure 3.7-10 General Nature of the Wepo Formation 3.7-32
Figure 3.7-11 Alluvial Aquifer Transmissivities 3.7-35
Figure 3.7-12 N-Aquifer Maximum Mine-related Proposed Action Pumping Drawdown 3.7-52
Figure 3.7-13 Simulated Stream Baseflow Locations 3.7-58
Figure 3.7-14 Springs Groups 3.7-60
Figure 3.7-15 Springs Groups and N-Aquifer Maximum Drawdown, Proposed Mine-related Pumping 3.7-63
Figure 3.7-16 N-Aquifer Maximum Cumulative Pumping Water Level Change 2020-2110 .... 3.7-100

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3.7 Water Resources

This resource section is organized similarly to that for other resources, wherein the study area definitions and a regulatory framework are presented first. Following these is a general discussion of the regional hydrologic setting. This is followed by detailed Affected Environment descriptions for the Navajo Generating Station (NGS) and then the proposed Kayenta Mine Complex (KMC), in sequence. These subsections discuss water resources characteristics, both recent and historical, for the immediate project area at each facility. Water resources in the broader, regional cumulative study areas are largely discussed in a separate appendix (**Appendix WR-8**) incorporated as part of the Environmental Impact Statement (EIS). The Affected Environment section is followed by the assessment of Environmental Consequences, with discussion of major project components aligned in a similar order. Additional reference information, more detailed data, and discussion are presented in water resources appendices. These are part of the EIS and can be further examined by more technically oriented readers.

3.7.1 Regulatory Framework

Both NGS and the Kayenta Mine have been constructed, operated, and maintained to address a number of environmental programs administered by several regulatory agencies. Project component designs, inspection and monitoring, maintenance, and reporting are major elements of regulatory permit approvals. These are reflected in the facilities and activities at both the NGS, the Kayenta Mine, and the transmission system, which are described further in Chapter 1.0.

3.7.1.1 Navajo Generating Station

The Salt River Project Agricultural Improvement and Power District (SRP) Operation and Maintenance Plan (**Appendix 1B**) and its appendices describe the components and environmental programs at NGS. **Table 3.7-1** summarizes the permits and programs involving water and its management at NGS. The SRP also has conducted groundwater monitoring at the plant site since plant operations began in the mid-1970's, and is revising its Groundwater Protection Plan in response to ongoing U.S. Environmental Protection Agency (USEPA) regulatory revisions including the coal combustion residual (CCR) rule. Additional regulatory programs for other materials or resources, such as wastes or air quality, are discussed in Chapter 1.0 and corresponding EIS sections.

As noted in **Table 3.7-1**, an industrial operating National Pollutant Discharge Elimination System (NPDES) permit is not required at NGS. With respect to industrial waste water, the plant operates as a zero-liquid-discharge facility. This is due to the water recycling design and operation of the plant, which include the use of brine concentrators and a crystallizer, as well as lined and monitored storage and evaporation ponds, to eliminate off-site industrial discharges. This is described further in the Operation and Maintenance Plan (**Appendix 1B**).

Storage tanks with up to 5 million gallons capacity exist at NGS for diesel fuel, and a number of other fuel or lubricant storage tanks with capacities ranging from 100 to 16,000 gallons also are present on-site. As implemented at NGS, the USEPA-approved Spill Prevention, Control, and Countermeasure (SPCC) Plan addresses containment requirements and the activities that would take place if a spill of a petroleum product occurred. Spill prevention and response for other materials are addressed in the storm water permit and program.

Table 3.7-1 Regulatory Programs for NGS Water Management

Permit or Requirement	Constituent Regulated	Agency / Jurisdiction
Safe Drinking Water Act	On-site potable water	No permit is required, but water operator(s) for the NGS potable water system are certified at the appropriate regulatory level.
National Pollution Discharge Elimination System Permit	Industrial waste water discharges	Exempt; no permit is required because there are no discharges
Multi-Sector General and Construction Permit for Stormwater Discharges	Stormwater discharges	USEPA
Clean Water Act Section 316(b) Cooling Water Intake Structure – Final Rule	Impingement and entrainment of aquatic life	USEPA
SPCC Plan	Possible oil spills from storage tanks	USEPA

3.7.1.2 Proposed Kayenta Mine Complex

Similar to NGS, water management at the Kayenta Mine is conducted in response to regulatory requirements and operational requirements such as dust suppression. The SPCC Plan at the Kayenta Mine addresses petroleum product containment requirements and response actions if a spill occurs. Relevant materials stored at the Kayenta Mine include gasoline, diesel and aviation fuels, lubricants and degreasers, transformers, and others. All tanks and containers have secondary containment such as lined spill boxes, berms, or double-wall designs or are operated within the facility drainage control system (which is secondary containment in accordance with SPCC requirements). No discharges to streams of these SPCC-related materials have occurred in the Kayenta Mine history (Peabody Western Coal Company [PWCC] 2012 et seq.). Other programs involving surface water and groundwater quantity, quality, and their protection at the Kayenta Mine are listed in **Table 3.7-2**.

Table 3.7-2 Regulatory Programs for Kayenta Mine Water Management

Permit or Requirement	Constituent Regulated	Agency / Jurisdiction
Surface Mining Control and Reclamation Act permit to conduct surface coal mining and reclamation operations	Surface water, groundwater, water supply, wastewater, monitoring and reclamation	Office of Surface Mining Reclamation and Enforcement (OSMRE) Indian Lands Program
Mine Safety and Health Administration design and safety standards for water, sediment, or slurry impoundments and impounding structures	Dams meeting regulated embankment sizes and/or storage volume capacities	Mine Safety and Health Administration
Navajo Nation Safe Drinking Water Act	On-site potable water	Navajo Nation Environmental Protection Agency (NNEPA)
National Pollution Discharge Elimination System Permit	Releases to receiving waters from sediment ponds, impoundments	USEPA in cooperation with OSMRE and the NNEPA Water Quality Program

Table 3.7-2 Regulatory Programs for Kayenta Mine Water Management

Permit or Requirement	Constituent Regulated	Agency / Jurisdiction
Multi-sector General Permit AZR051000	Storm water	USEPA Region 9
Nationwide Permit 21	Dredge and fill in Waters of the U.S.	U.S. Army Corps of Engineers
Public Water System Permit	Potable water	NNEPA – Public Water Systems Supervision Program
Clean Water Act Section 401 Water Quality Certification	Releases to receiving waters from sediment ponds, impoundments, reclaimed drainages	NNEPA – Water Quality Program, Hopi Tribe Department of Natural Resources – Water Resources Program
Wastewater Treatment System Permits	Sanitation facilities (domestic wastewater)	NNEPA
Water Well Drilling & Completion, Use, Abandonment	Groundwater	Water Code Administration (within the Navajo Nation Department of Water Resources), and the Hopi Tribe Department of Natural Resources – Water Resources Program
SPCC Plan	Possible spills of petroleum products from storage tanks	USEPA

Water supply and sanitary facilities at the Kayenta Mine are constructed, operated, and maintained in accordance with the Safe Drinking Water Act and related system permits through the NNEPA. In addition to industrial uses of the wellfield, some of the supply wells (NAV series of N-Aquifer water wells) have been operated as part of the potable water system. Currently NAV wells 2, 6, and 8 are used for potable supply; other configurations have been used historically. The N-Aquifer wells also are used for dust suppression, fire suppression, and livestock drinking water. Coal lease agreements require equal payments to the Navajo Nation and Hopi Tribe for withdrawal and use of N-Aquifer water. In addition, PWCC N-Aquifer withdrawals provide public potable water supplies made available to local residents from certain NAV wells at two public water stands. NAV well construction and any subsequent actions such as capping and abandonment are regulated by tribal authorities as noted above (**Table 3.7-2**).

Surface Mining Control and Reclamation Act regulations and the approved Kayenta Mine permit form a major basis for water management and monitoring at the Kayenta Mine. The regulatory program guides baseline water resources characterization; assessment of potential impacts; and the design, construction, and operation of water controls to address protection of the hydrologic balance. Mine and facility drainage is necessary for operations. The control features involved are discussed in Chapter 1.0. Ditches, diversions, and sediment ponds are configured, inspected, and maintained at the Kayenta Mine according to (or in excess of) the Surface Mining Control and Reclamation Act permit requirements, and Mine Safety and Health Administration requirements as applicable. Surface water and groundwater monitoring are conducted throughout the lease areas, and detailed reports are submitted annually as part of permit compliance. Overburden/interburden characterization and handling, regrading to approximate original contours, and restoration of stable drainages and landforms are part of reclamation activities performed in accordance with the Surface Mining Control and Reclamation Act permit. These reclamation activities help control runoff, runoff water quality, groundwater quality, and seepage on reclaimed lands. Other reclamation protections include bonding and release requirements.

In concert with Surface Mining Control and Reclamation Act permit provisions, the NPDES System permit and the Clean Water Act Section 401 Water Quality certifications guide activities that control the amount and quality of stormwater runoff, industrial facility runoff, and sediment discharged from the Kayenta Mine. The purpose of these regulatory programs is to maintain or improve water quality, with the overall goal of sustaining (or achieving) designated surface water uses. For the Kayenta Mine, the USEPA Region IX is the permitting authority for wastewater discharge under the NPDES; OSMRE is the permitting authority for the mining permit pursuant to Surface Mining Control and Reclamation Act (OSMRE 2003). Wastewater and storm water management requirements overlap considerably between the Surface Mining Control and Reclamation Act and NPDES programs. Releases to receiving waters must comply with permit requirements, and monitoring is required and conducted to ascertain water quality. Receiving waters in the Kayenta Mine permit area include Coal Mine Wash, Moenkopi Wash, Dinnebito Wash, Yellow Water Canyon Wash, and their applicable tributaries (**Figure 3.7-3**).

The NPDES program and its related permits are administered by the federal USEPA. USEPA stormwater permit AZR05F121 is issued under the 2015 Multi-Sector General Permit for Stormwater (USEPA 2015, 2010). The storm water permit applies to storm water discharges from outfalls on Shonto Wash, Laguna Creek, Coal Mine Wash, Yellow Water Canyon Wash, and Moenkopi Wash. Storm water runoff from limited areas including haul road crossings and access roads along the coal conveyor beltline is treated by structural or non-structural best management practices in accordance with the Storm Water Pollution Prevention Plan. Additional management practices related to materials storage, employee training and good housekeeping, inspections and maintenance, and monitoring and reporting also are implemented.

Industrial discharges to surface waters are reported to USEPA under point source permit NN0022179 for treated wastewater. The wastewater permit is for alkaline mine drainage, drainage from coal preparation areas, and western alkaline reclamation according to USEPA categories. For reclaimed mine areas that qualify under the western alkaline reclamation category, the wastewater permit relies on the use of Best Management Practices identified and implemented through a Sediment Control Plan. The plan identifies Best Management Practices and design specifications, construction specifications, maintenance schedules, and criteria for inspection, as well as the expected performance and longevity of the Best Management Practices (OSMRE 2003). USEPA, OSMRE, the Tribes, and the Bureau of Indian Affairs conduct concurrent reviews of the permit during the application process. OSMRE receives reports cooperatively through the Surface Mining Control and Reclamation Act monitoring program requirements and its Memorandum of Understanding with USEPA. Under the NPDES program, USEPA, OSMRE, and the Tribes are to coordinate closely on inspections of the sediment controls included in the NPDES and Surface Mining Control and Reclamation Act permits (OSMRE 2003).

3.7.1.3 Tribal Water Quality Standards

Tribal water quality standards, based on designated uses, narrative and numeric criteria, and anti-degradation policies, form the basis for more specific receiving water standards and related water management at NGS and Kayenta Mine. NNEPA administers the water quality standards for surface water and groundwater on Navajo lands. The Hopi Tribe Water Resources Program administers the water quality standards for surface water and groundwater on Hopi lands. Criteria apply generally or more specifically, based on uses of designated surface waterbodies and their tributaries. Common designated uses of surface waters on tribal lands include livestock watering, human full body and/or partial body contact, domestic water supply, and aquatic and wildlife habitat. Surface water and groundwater supplies for domestic water purposes are subject to Safe Drinking Water regulations and criteria. Both tribal groundwater programs are based on the Safe Drinking Water Act. Designated uses and related criteria are described in more detail in **Appendix WR-1, Tables WR-1.1** through **WR-1.4**.

In addition to domestic wastewater regulations, both the Hopi Tribe and the Navajo Nation have developed wellhead protection programs to address potential groundwater contamination sources at or near water supply wells (Hopi Tribe Water Resources Program 1996; NNEPA 2010). These programs have been developed to protect groundwater supplies for residents and to safeguard health, resources, and property in the vicinity of existing and potential water supply wells and springs. Septic tanks, sewage lagoons, active or abandoned mines, abandoned or unauthorized dumping areas, and underground storage tanks are some of the highest priority contaminant sources. Examples of other residential, commercial, industrial and municipal contaminant sources also are listed in the plans or their appendices.

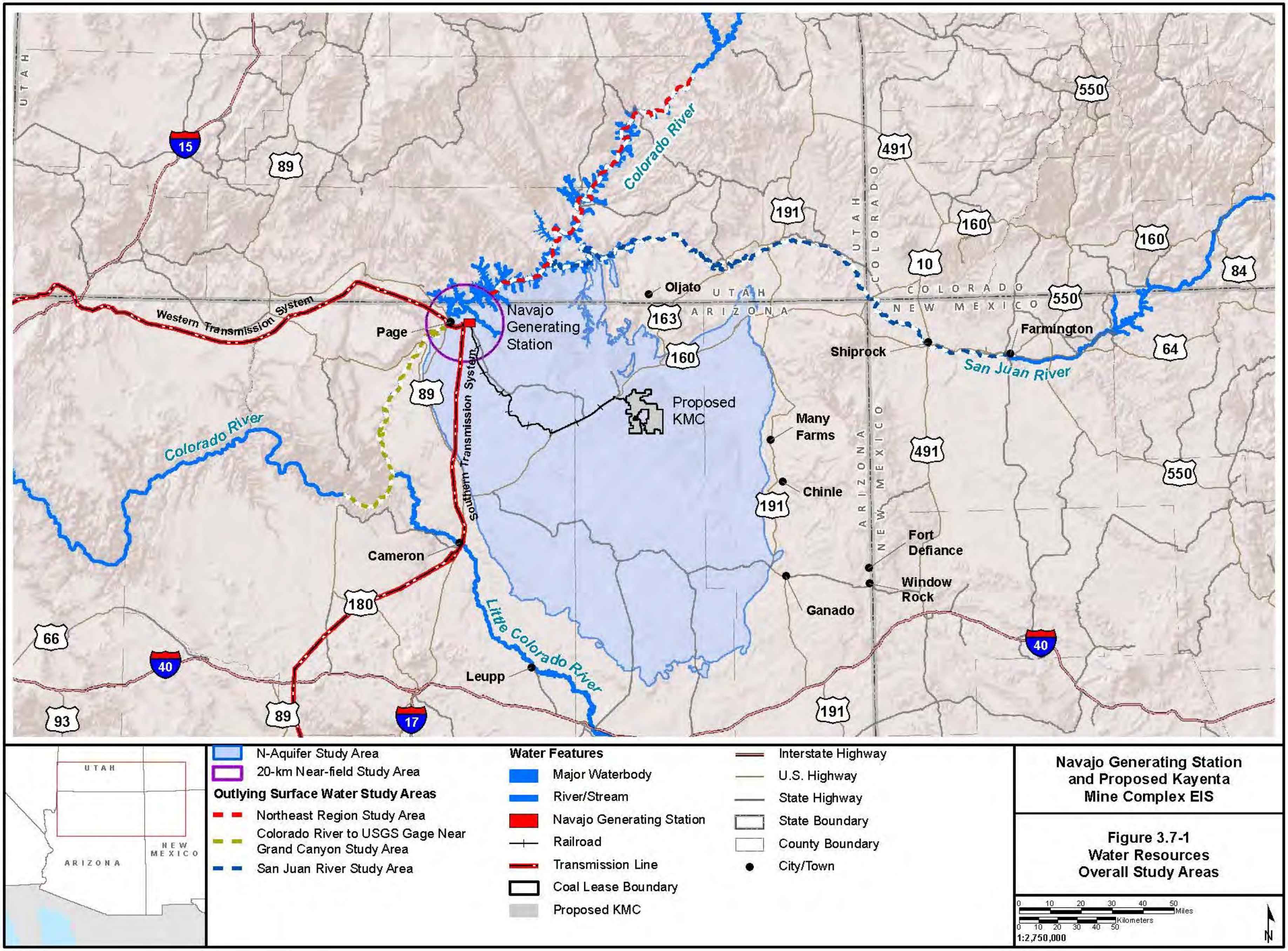
The principal areas of concern for the Hopi wellhead protection program are the unconfined N-Aquifer in the Moenkopi area and springs emanating from the near-surface Toreva and Wepo formations. Since many of the springs used by Hopi villages emanate from the near-surface Toreva or Wepo Formation, protection of these areas from potential surface contamination is a priority for the tribe. Consequently, the Hopi wellhead protection manual recommends that the wellhead protection program also be applied to springs. In that document, the terms “well” or “wellhead” also include springs (Hopi Tribe Water Resources Program 1996). Prevention of contamination through wellbores in confined water supply wells also is an important issue undertaken through the Hopi wellhead protection program (Hopi Tribe Water Resources Program 1996).

3.7.1.4 Transmission Systems and Communication Sites

Regulatory programs pertaining to water resources along or at the Western Transmission System (WTS) and the Southern Transmission System (STS) include construction or operation/maintenance storm water protection plans, SPCC plans, and Rights-of-Way (ROWs) permit stipulations determined by authorizing agencies. For example, these may include requirements for erosion controls; vehicle and equipment parking related to floodplains, wetlands, or springs; location of staging or storage areas; channel protection measures at access road crossings; or the timing of work around surface flows. One example includes provisions in the U.S. Army Corps of Engineers Nationwide Permit 12 (Utility Line Activities) for transmission line crossings of Waters of the United States (U.S. Army Corps of Engineers 2012); another is the content/questionnaire in BLM (Bureau of Land Management) Standard Form 299 (Application for Transportation and Utility Systems and Facilities on Federal Lands) (BLM 2009a) and the corresponding Plan of Development guidelines for construction (e.g, “Earthwork” and “Stabilization, Rehabilitation and Revegetation”) and other operation and maintenance information requirements for a BLM ROW application (BLM 2009b).

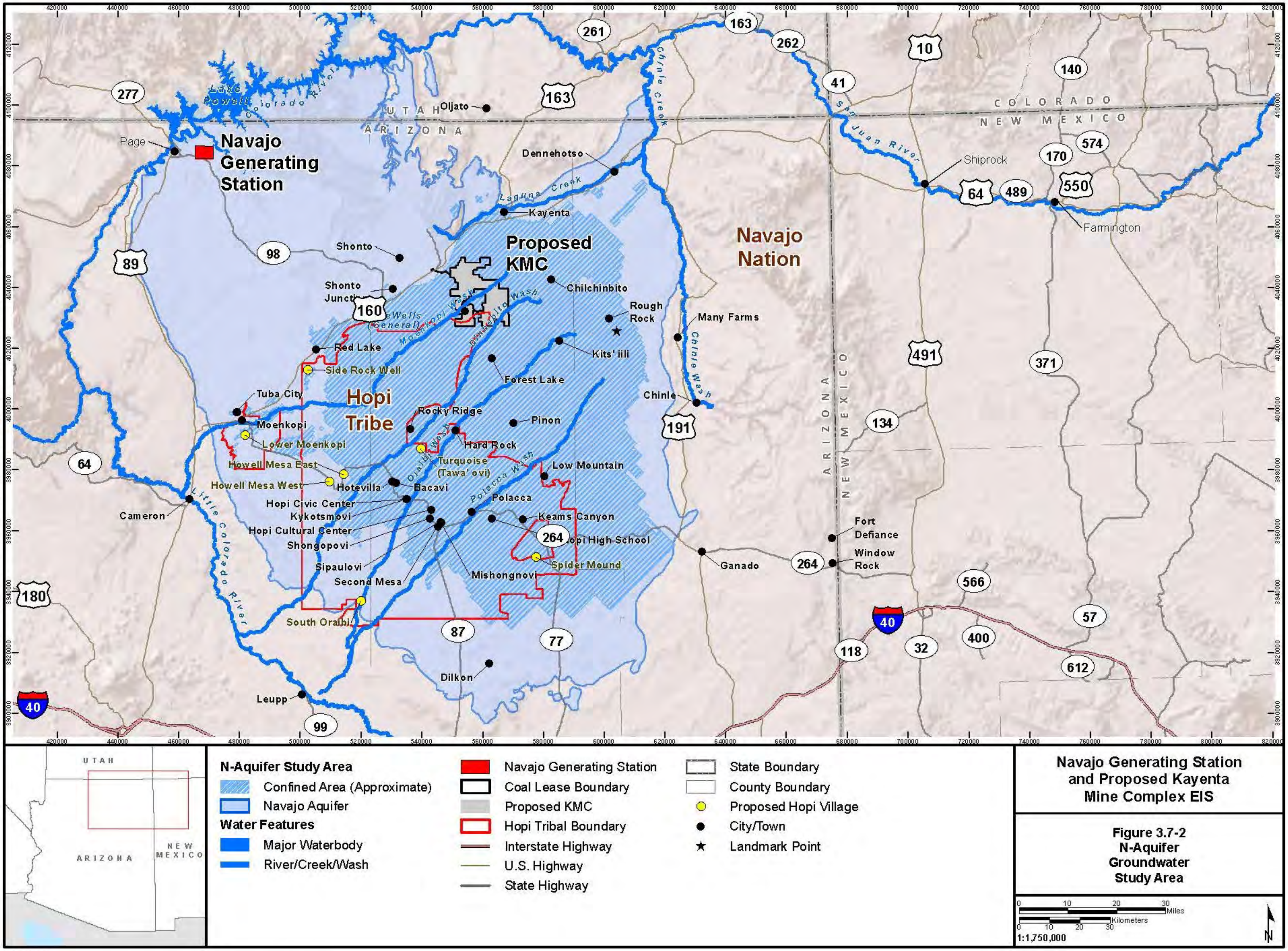
3.7.2 Study Areas

The water resources study areas are located in a portion of the Colorado Plateau region of northeastern Arizona. **Figure 3.7-1** depicts the study areas. For groundwater resources, the study area includes the N-Aquifer footprint as it occurs in the lower San Juan and Colorado river basins of northeastern Arizona (**Figure 3.7-2**). The N-Aquifer is a major source of springs and potable water in the region; its study area occupies approximately 10,400 square miles. The groundwater study area is bounded on the north by the lower San Juan River, Lake Powell, and the Colorado River. It is bounded by Chinle Wash/Chinle Creek to the east, and elsewhere by the outer limit of the N-Aquifer as indicated on **Figure 3.7-2**. Hydrologic features overlying the N-Aquifer, including other groundwater-bearing zones, springs and seeps, stream channels, ponds, and other water supply features, are included in the assessment.



Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 3.7-1 Water Resources Overall Study Areas



Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 3.7-2
N-Aquifer Groundwater Study Area

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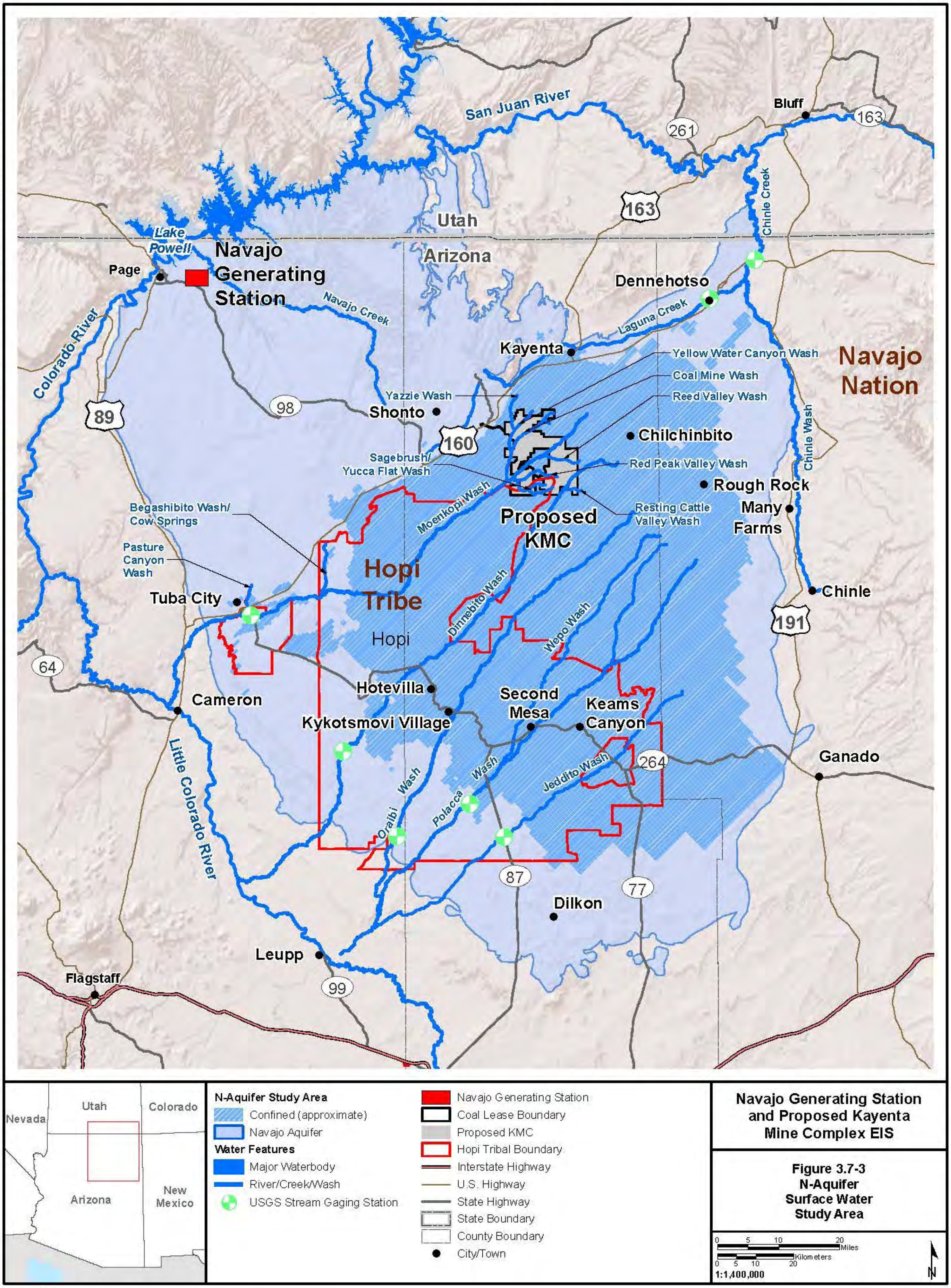

Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 3.7-3
N-Aquifer Surface Water Study Area

3.7.2.1 Navajo Generating Station

Two surface water study areas also are shown on **Figure 3.7-1**. In coordination with the Ecological Risk Assessment (ERA) and Biological Resources assessments (Section 3.13), the NGS study area includes the Colorado and San Juan rivers as they enter Lake Powell, their courses through Lake Powell itself, and the Colorado River downstream of Glen Canyon Dam to the U.S. Geological Survey (USGS) streamgage at Lees Ferry (USGS 09380000). A 20-kilometer (km) radius from the NGS is included in that surface water study area.

3.7.2.2 Proposed Kayenta Mine Complex

For the proposed KMC, a separate surface water study area is defined in association with the N-Aquifer footprint. This surface water study area is bounded by USGS gages on channels draining the Black Mesa area. As shown on **Figure 3.7-3**, these include the gaging stations on Moenkopi Wash at Moenkopi (USGS 09401260), Dinnebito Wash near Sand Springs (USGS 09401110), Oraibi Wash near Tolani Lake (USGS 09400562), Polacca Wash near Second Mesa (USGS 09400568), and Jeddito Wash near Jeddito (USGS 09400583). The proposed KMC surface water study area also includes Laguna Creek (USGS 09379180) and Chinle Wash/Chinle Creek (USGS 09379200) draining to the San Juan River. Pasture Canyon, Begashibito Wash, and other tributaries to these major washes are included.

3.7.2.3 Transmission Systems and Communication Sites

For the transmission systems, the surface water study area follows the WTS and STS ROWs. Perennial, intermittent, and ephemeral streams cross the WTS and STS as depicted on **Figure 3.7-1**.

3.7.3 Affected Environment

The following Affected Environment sections are typically based on data collected from the period 2010 through 2014. The purpose of this time-frame is to identify existing conditions within the project area as a recent background for future alternatives. In some cases, longer time intervals and broader spatial coverage have been included here to better describe the resource setting and related factors. For the most part, additional water resource data for longer timeframes and regional aspects are further described in **Appendix WR-8** (Cumulative Water Resources Supplement), and in longer-term data summaries in other Water Resources appendices. Cumulative impact assessments (in Environmental Consequences) cover a broader timeframe, as well as other actions.

3.7.3.1 Regional Overview

3.7.3.1.1 Precipitation and Evaporation

Precipitation in the study area primarily falls during two parts of the year. Rainfall is greatest during the July through September monsoon season, and a relatively wet period also occurs during the winter months (December through March) (Arizona Department of Water Resources 2010b). Substantial variability occurs between individual years. Shifts between wetter and drier periods also are common on longer, 10- to 20-year (decadal) time scales (Arizona Department of Water Resources 2010b). Generally lower precipitation rates have occurred since about 1995.

Average annual precipitation generally varies with elevation in the study area. Historically, precipitation has been the greatest (approximately 14 inches a year) at the highest, northern edge of Black Mesa near Yale Point (Arizona Department of Water Resources 2010a). Average annual precipitation declines as the mesa slopes downward to the south and west. Generally between 10 to 12 inches are received annually at Piñon and between 8 to 10 inches at Kykotsmovi. At lower elevations, about 6.5 inches per year are received on average at Page, Tuba City and Leupp, and about 7 inches at Many Farms (Western Regional Climate Center 2015a). The mean annual precipitation increases eastward to about

9 or 10 inches at Chinle, Ganado, and on the Defiance Plateau. Mean annual precipitation is 7 to 8 inches per year in the Shiprock-Farmington area of New Mexico.

Widely scattered convective thunderstorms generally occur in the earlier summer months, and monsoonal rainfall events occur later in summer and early fall. Examples of precipitation totals by month are indicated in **Table 3.7-3**, where the changes from June to July values are notable.

Table 3.7-3 Average Monthly Precipitation at Selected Stations

Location[1]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Kayenta	0.46	0.47	0.55	0.38	0.39	0.28	1.18	1.40	0.75	0.87	0.44	0.48
Pinon	0.59	0.68	0.61	0.48	0.13	0.23	1.22	0.77	1.07	1.4	0.54	0.98
Betatakin	1.09	0.95	0.94	0.75	0.46	0.34	1.37	1.63	1.2	1.18	0.9	1.16

[1] Periods of record vary.

Source: Western Regional Climate Center 2015a.

As discussed in Section 3.2, the National Climate Assessment (Walsh et al. 2014) shows a 10 to 15 percent reduction in local precipitation over northeastern Arizona when comparing the 1991 through 2012 annual average to the 1901 through 1960 annual average. A region-wide comparison was performed for this EIS to compare precipitation data from five federal stations: Betatakin, Grand Canyon, Page, Winslow, and Canyon de Chelly. The results of this comparison indicated that the period 1995 through 2012 had about 15 percent lower precipitation than 1970 through 1994, statistically significant at a 5 percent significance level.

Documentation of drought in the western Navajo/Hopi region is difficult, due to the variety of climatic and topographic characteristics and the sparseness of standardized weather stations. The recent drought began in about 1999, although some residents maintain that it started in 1996 or before (Redsteer et al. 2010). In the western Navajo Nation, below-normal rainfall was recorded beginning in 1994. It is possible that drought may have begun then in the drier western part of the Navajo Nation, and became more regionally extensive in following years (Redsteer et al. 2010). The frequency of wind, sand, and dust storms were indicated as being more common in the 1950s, and were noted to be increasing again in the 1990s.

In addition, substantial increases in evapotranspiration occurred during the warm seasons of the early 2000s, due to increasing temperatures (Redsteer et al. 2010). Annual pan evaporation averages approximately 80.6 inches at Page, approximately 84.7 inches at Winslow, and approximately 90.8 inches at Many Farms School (Arizona Department of Water Resources 2010a; Western Regional Climate Center 2015b). Assuming a pan coefficient of 0.70, annual evaporation losses from a free-water surface (such as a pond or lake) would be approximately 56.4 inches at Page, 59.3 inches at Winslow, and 63.6 inches at Many Farms. On a long-term average basis, evaporation and evapotranspiration losses are substantially greater than precipitation rates, creating the arid to semi-arid conditions in the study area. Surface water flows and groundwater recharge occur over relatively short periods when rainfall overrides evaporation and transpiration losses.

3.7.3.1.2 Groundwater

Groundwater resources in the study area consist of several aquifer zones. These are depicted on **Figure 3.7-4**.

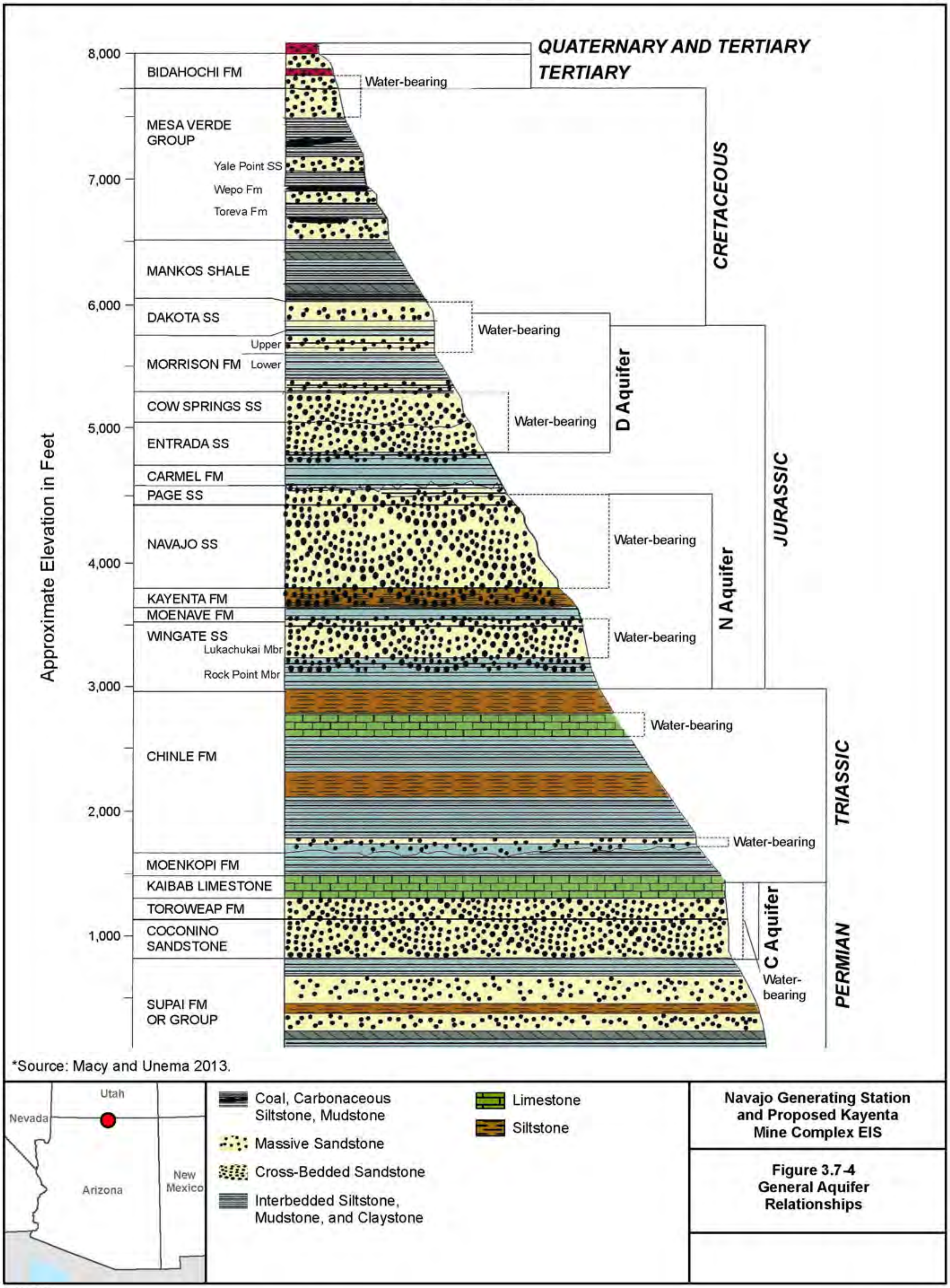

Figure 3.7-4 General Aquifer Relationships

7/20/2016

The distribution and properties of geologic materials underlying the NGS/Kayenta Mine area control the occurrence and movement of groundwater in the project study area. **Figure 3.7-4** depicts the general stratigraphic arrangement of all the consolidated geologic units in the regional (cumulative) study area. Only some of these are relevant to the individual project components (e.g., the generation station or the mine). In particular, only the Carmel Formation and deeper formations (including the N-Aquifer) underlie the NGS and outlying parts of the cumulative study region. Most of the stratigraphic column depicted on **Figure 3.7-4** underlies the Kayenta Mine. Additional information about these units is presented in **Appendices WR-5** and **WR-6**.

Stratigraphic units can be grouped based on their ability to retard or promote groundwater movement. Those that limit or prevent groundwater movement are called aquicludes or aquitards. Those that allow or promote groundwater movement, where saturated, are called aquifers. Hydrostratigraphic units in the NGS/Kayenta Mine area include the following:

- Wepo and Toreva Aquifers;
- Mancos Shale (aquitard);
- D-Aquifer System (Dakota, Morrison/Cow Springs, Wanakah, Entrada);
- Carmel Siltstone (aquiclude);
- N-Aquifer System (Page, Navajo, Kayenta, Moenave, Wingate);
- Chinle and Moenkopi Formations (aquiclude);
- C-Aquifer (Kaibab, Coconino);
- Supai Formation (aquiclude); and
- R-Aquifer System (Redwall/Muav).

The Wepo Formation is at the surface in the PWCC leasehold and, with local stream alluvium, comprises the shallow groundwater aquifer system. These aquifers supply water to windmills and groundwater to seeps and springs. Mining activities remove coal from the Wepo Formation. The Toreva Formation is an additional water-bearing zone underneath the Wepo Formation, but is not affected by mining. The Toreva Formation provides water to wells and springs at lower elevations on Black Mesa.

The Mancos Shale is a Cretaceous claystone and siltstone from 500 to 1,800 feet thick in the study area. It is low-permeability and serves as an effective aquitard, significantly limiting groundwater movement from the overlying Wepo and Toreva aquifers to the underlying D-Aquifer.

The Jurassic-Cretaceous sedimentary rocks of the San Rafael Group, including the Dakota Sandstone, Morrison Formation and Entrada Sandstone, comprise the D-Aquifer System over Black Mesa and isolated mesas of the Kaibeto/Rainbow Plateaus. The D-Aquifer System is composed of only the Dakota Sandstone and Morrison Formation northeast of the Chinle Wash drainage. The aquifer is not present in the NGS area, where the uppermost unit is the Carmel Formation. On Black Mesa, windmill wells are mainly constructed in the D-Aquifer.

The Carmel Formation is a siltstone with some sandstone of Middle Jurassic age that ranges from zero to about 300 feet in thickness in the cumulative study area. Over much of Black Mesa, including the coal lease area, the unit is a siltstone greater than 120 feet thick and is an effective aquiclude; in these areas the Carmel Formation acts as a confining layer to the underlying N-Aquifer. In the southern part of Black Mesa where it is sandier and less than 120 feet thick, it allows more downward migration of groundwater from the D- to N-Aquifer than in other areas (Truini and Macy 2006). The Carmel Formation is at the surface at the NGS (**Appendix 1B**).

The N-Aquifer includes: the Triassic-Jurassic Wingate Sandstone, Moenave Formation, Kayenta Formation, Navajo Sandstone and Page Sandstone of the Glen Canyon Group. The Page Sandstone is essentially identical to the Navajo Sandstone, but is separated from it by a regional erosion surface and is found (overlying the Navajo Sandstone) only beneath the isolated mesas of the Kaibeto/Rainbow Plateau near Page, Arizona. The Page Sandstone is typically discussed in concert with the Navajo Sandstone. The Moenave Formation is found only in the far southwest of the Black Mesa Basin and typically is discussed with the Kayenta Formation. The Wingate Sandstone, Kayenta Formation, and Navajo Sandstone occur over much of the study area. Together these sequences comprise the N-Aquifer, which is the principal source of industrial (Kayenta Mine) and municipal water in the study area.

Beneath the N-Aquifer lies the Chinle Formation, which consists mainly of siltstone, silty sandstone, and mudstone, occasionally interbedded with sandstones. As an aquiclude, it limits or prevents groundwater movement between the N-Aquifer and the underlying C-Aquifer. Within the study area, the N- and underlying C-Aquifer systems are separated by approximately 1,000 feet of relatively impermeable Chinle and Moenkopi Formations (OSMRE 2011a). There is little hydraulic communication between the two aquifer systems.

The C-Aquifer, comprised of the Permian Kaibab Limestone and Coconino Sandstone, underlies much of the study area. However, it is buried to a depth of approximately 5,000 feet beneath the Kayenta Mine and separated from the overlying N-Aquifer by approximately 1,800 feet of siltstone and claystone of the Chinle and Moenkopi Formations. Beneath the NGS, the C-Aquifer, if present, is at a depth of more than 2,000 feet below ground surface (bgs). North of the Little Colorado River, the C-Aquifer is generally too deep to be an economic water source for most supplies, or it is otherwise unsuitable for most uses due to elevated concentrations of Total Dissolved Solids (TDS) (Arizona Department of Water Resources 2010b). While the C-Aquifer is a viable source of potable water south of the Little Colorado River, it is not proposed for use at the NGS or Kayenta Mine. Therefore, it would not be impacted by operations at these facilities, and is not considered further.

The Supai Formation is an aquiclude between the C- and R-Aquifers. It consists of alternating sandstone and siltstone units.

The deepest aquifer system in the study area, referred to as the “R-Aquifer,” is comprised of the Cambrian-Mississippian Redwall and Muav Limestone Formations. In the study area these units are not exposed at the surface except in the gorges of the Little Colorado and Colorado Rivers where high salinity water (over 3,000 milligrams per liter [mg/L]) from the aquifer discharges to the rivers. No water supply wells penetrate the R-Aquifer beneath the NGS/Kayenta Mine facilities; therefore, this aquifer system is not further addressed in this document.

3.7.3.1.3 Surface Water

Surface water resources in the study area include Lake Powell along its Colorado and San Juan river arms, the Colorado River downstream of Lake Powell to the USGS streamgage at Lees Ferry (USGS 09380000), and several major drainages on or near Black Mesa. Major channels in the Black Mesa region that drain to the Little Colorado River include Moenkopi Wash, Dinnebito Wash, Oraibi Wash, Polacca Wash, and Jeddito Wash (**Figure 3.7-3**). Pasture Canyon, and Begashibito and Shonto washes are major tributaries to Moenkopi Wash in the Tuba City/Moenkopi area. Along the north side of Black Mesa, Laguna Creek drains to Chinle Creek, which in turn drains to the San Juan River.

The Colorado River is impounded by Glen Canyon Dam near Page, Arizona, forming Lake Powell. At its nominal full pool elevation (3,700 feet above mean sea level [amsl]), Lake Powell extends 186 miles up the Colorado River and 75 miles up the San Juan River (Ferrari 1988). **Table 3.7-4** indicates other reservoir characteristics. Lake Powell characteristics are described further in **Appendix WR-8**.

Table 3.7-4 Lake Powell Magnitudes

Reservoir Pool Status	Water Surface Elevation (feet amsl)	Capacity (acre-feet)	Extent (acres / square miles)
Full Pool	3,700	26.2 million	160,784 / 252.2
Lowest Historical (2005)	3,555	9.8 million	73,787 / 115.3

Source: Reclamation 2007.

A century of river flow records indicates that long and severe droughts are not unusual in the American Southwest (Lindsey 2015). For example, during the 15-year period from 2000 to 2014, the unregulated inflow to Lake Powell was above average in only three out of the 15 years. The period 2000 through 2014 is the lowest 15-year period recorded since the closure of Glen Canyon Dam in 1963. Since the year 2000, the average unregulated water-year inflow has been approximately 8.4 million acre-feet, or 78 percent of the 30-year average from 1981-2010 (Reclamation 2015a).

On Black Mesa, runoff from precipitation creates the greatest streamflows in the washes. Comparatively minor flows result from snowmelt. Most flows occur from convective thunderstorms in the earlier summer months, and from monsoon-related frontal rainfall events later in summer and early fall. Because of this, the uppermost reaches and tributaries of Moenkopi Wash, Dinnebito Wash, Oraibi Wash, and others are ephemeral, with short periods of flow in response to runoff. In scattered locations where aquifers contribute seasonal baseflows to the stream channels, the washes exhibit flowing water intermittently. Evapotranspiration and seepage into the deeper alluvial deposits typically limits such reaches to short, isolated stream segments. Some washes are perennial at lower elevations, with small year-round flows from groundwater contributions. Lower Moenkopi Wash, Pasture Canyon, lower Dinnebito Wash, and lower Polacca Wash have small perennial flows.

Based on historical research, substantial reductions in the number and length of perennial stream reaches have been recorded since the mid-1900s (Arizona Department of Water Resources 2008; Cooley et al. 1969; Redsteer et al. 2010). Historical riparian alterations are thought to have begun in the 1940s, due to the adaptation of more salt- and drought-tolerant vegetation to the drier conditions (Redsteer et al. 2010). Investigators also noted that portions of Laguna Creek, upper Polacca Wash, lower Moenkopi Wash, middle Jeddito Wash, and lower Chinle Wash formerly were perennial in the early to mid-1900s, but had become dryer by the 1960s (Cooley et al. 1969; Redsteer 2012). Depending on location, parts of these reaches are intermittent or ephemeral now. Changes to ephemeral conditions became more extensive along Moenkopi Wash and Chinle Wash after 1960. Interviews with numerous tribal elders indicated a long-term decrease in annual snowfall, a decline in surface water features and water availability, and the disappearance of springs since about 1994 (Redsteer et al. 2010).

Precipitation cycles and changes in streamflow regimes have been widely recognized in the American Southwest (Hereford 2007; Karlstrom 1988; National Research Council 2007). Along with the wet and dry climate cycles, flow durations in stream reaches also are subject to complex relationships between arroyo cutting, sediment infilling, channel responses to floods, and adjacent groundwater levels. All of the streams store and transport large volumes of sediment along their channels. Bank erosion and headcuts are common throughout the study areas.

In addition to rivers, streams, and washes, small stock ponds are scattered throughout the study area. On Black Mesa, they are located on tribal lands outside the leasehold, or are part of mine water controls within the leasehold. A number of stock ponds, and diversions that direct runoff to them, are not project-related and are located downstream of the leasehold along Dinnebito Wash. These downstream features affect flow conditions below the leasehold, which are of interest based on public scoping inputs. Retention structures on the leasehold have either a temporary or permanent status, depending on their function during mining or after reclamation. In addition to ponds, tanks at windmills supply water for livestock at scattered locations.

3.7.3.2 Navajo Generating Station

The NGS is located approximately 60 miles northwest of the Kayenta Mine on the south side of the Colorado River near Page, Arizona. The plant site is about 3 miles from Lake Powell. The facilities are further described in Chapter 1.0 and **Appendix 1B**. In addition to other topics, parts of **Appendix 1B** that are of major interest to water resources include:

- The “Water Use and Management in Plant Operations” text section;
- The “Oil and Chemical Storage” text section;
- The “Wastewater Management” portion of the “Waste Management” text section;
- Supplemental **Appendices B** and **C** (respectively, the CCR Ash Disposal Landfill Requirements, followed by the Groundwater Protection Plan);
- Groundwater Protection Plan supplemental **Appendices C(1)** and **C(2)**, which respectively include the “Perched Water Dewatering Work Plan” and results from the NGS groundwater monitoring program (1978 to the present);
- Best management practices and mitigation measures for water quality in supplemental **Appendix E**.

3.7.3.2.1 Groundwater at NGS

3.7.3.2.1.1 Aquifer Configuration

The Mesa Verde and D-Aquifer zones are absent in the NGS area; the Carmel Formation is at the surface beneath most of the NGS facilities and, where present, forms a thin veneer over the Page Sandstone, which in turn overlies the Navajo Sandstone (**Figure 3.7-5**). The Carmel Formation is absent beneath the Solid Waste Landfill and Ash Disposal Area, which are underlain by the Page and Navajo sandstones (**Appendix 1B**). In some areas, the Carmel Formation is overlain by dune sand up to about 15 feet thick. The dune sands are unconsolidated wind-blown materials eroded from various formations (primarily the Navajo Sandstone). The Carmel Formation itself ranges in thickness from zero to about 70 feet. The Page Sandstone is not differentiated from the Navajo Sandstone in monitor well logs; however, it is separated from the Navajo Sandstone by an unconformity. The Navajo Sandstone is approximately 1,400 feet thick in the NGS area and is unconfined, with the water level at a depth of about 900 feet bgs. Due to the depth of groundwater, no wells produce water from the Navajo Sandstone in the NGS area; the plant and nearby City of Page rely on surface water from the Colorado River to meet processing and potable needs (**Appendix 1B**). The Black Mesa & Lake Powell Railroad starts at the PWCC leasehold and travels northwest 78 miles to the NGS, as shown in Chapter 1.0. The railroad traverses the unconfined portion of the N-Aquifer over most of its length. Water levels in the aquifer in this area range near the land surface at the shallowest point near Cow Springs, to about 900 feet bgs at its terminus at the NGS.

Prior to 1981 groundwater in the N-Aquifer flowed toward the Colorado River. However, due to the filling of Lake Powell (starting in 1960), water levels in the aquifer beneath the NGS have risen from 40 to 80 feet since the early 1980s. Groundwater flow also has changed from southeast–northwest, to northeast–southwest (**Appendix 1B**).

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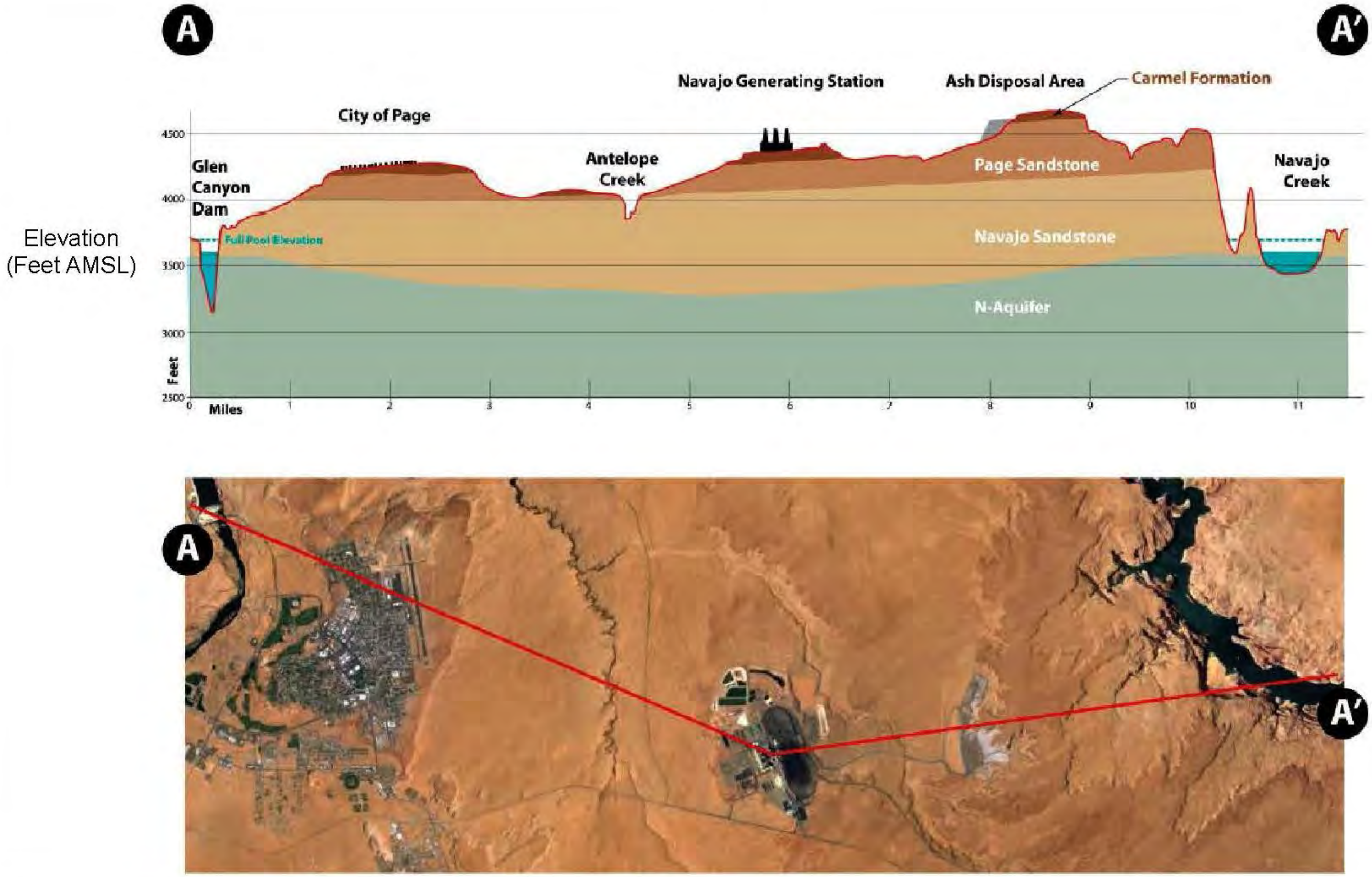

Source: Salt River Project 2015

Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 3.7-5

Stratigraphy at NGS

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No groundwater supplies are used at NGS. A number of shallow and deep monitoring wells have been constructed since the 1970s. These are further described in the Operation and Maintenance Plan (**Appendix 1B**). Three deep wells monitor the N-Aquifer. General characteristics of the three deep wells used to monitor the N-Aquifer at NGS are summarized in **Table 3.7-5**. The depths of open boreholes vary.

Table 3.7-5 Deep Monitoring Wells at NGS

NGS Deep Well	General Location [1]	Land Surface Elevation (feet amsl)[2]	Total Well Depth, (feet bgs)[3]	Depth to Water, (feet bgs)[3]	Water Elevation, (feet amsl)[2,4]
DW-1	Northwest part of plant area, near plant perimeter at wastewater management ponds	4,298.6	1,200	833.2	3,465.4
DW-2	Inside the southwest part of the rail loop	4,366.2	1,500	906.0	3,460.2
DW-3	Northwest corner of dry ash disposal area	4,434.1	1,500	918.3	3,515.8

1 These features are depicted on figures accompanying Chapter 1.0.

2 Elevation in feet, referenced to above mean sea level (amsl).

3 Depth in feet below ground surface (bgs).

4 Data from May, 2015.

Source: **Appendix 1B**.

Data from these deep monitoring wells at NGS indicate that the groundwater levels in the N-Aquifer in the plant vicinity have risen about 1 to 2 feet per year (**Appendix 1B**). A Reclamation study in 1969 indicated that groundwater levels will rise to an elevation of approximately 3,550 to 3,600 feet amsl beneath NGS, in response to recharge from Lake Powell (**Appendix 1B**). Assuming that the observed water level rises are due to lake-generated aquifer recharge and using 1 to 2 feet per year rate of rise, hydraulic equilibrium would be reached in the next 50 to 100 years based on the earlier Reclamation study (**Appendix 1B**). If this occurs and the earlier predictions are correct, N-Aquifer water would still be approximately 700 to 766 feet or more bgs at the plant site, and approximately 824 feet or more below the ground surface at Well DW-3 at the dry ash disposal area.

3.7.3.2.1.2 Aquifer Parameters

Estimated hydraulic conductivity of the hydrogeologic units beneath the NGS area is summarized in **Table 3.7-6**.

Table 3.7-6 NGS Unit Hydraulic Conductivities

Hydrologic Unit	Hydraulic Conductivity (feet/day)
Dune Sand	2.5 to 4.7
Carmel	<0.003 to 0.25
Page/Navajo Sandstone	0.03 to 1.1

Source: **Appendix 1B**.

3.7.3.2.1.3 Groundwater Quality

Prior to the construction of the NGS, the upper hydrologic units were unsaturated, with the water table being in the N-Aquifer at a depth of about 900 feet bgs. However, leakage from previously unlined ponds and other sources at the site has created a local perched water table in the low permeability layers of the Carmel Formation beneath portions of the plant site. In 2012, depth-to-water in this perched system ranged from about 7 to more than 20 feet bgs. Water levels are reported to be dissipating in the plant pond areas since the ponds were lined. However, leakage appears to be continuing in the cooling tower area.

As described in the Groundwater Protection Plan (Appendix C to **Appendix 1B**) and its supplemental Appendix 1 (Perched Water Dewatering Plan), routine inspections, pond leak detection, perched water recovery and monitoring, N-Aquifer monitoring, and mitigation activities have been instituted and coordinated with the USEPA. Dewatering activities have been instituted and are ongoing, and will recover perched water beneath the plant via recovery wells. Extracted water is reclaimed into plant processes. Ongoing activities will address the factors contributing to the presence of leaked water, which is retained in the low permeability Carmel Formation. In general, activities will include upgrades to the pond liners, upgrades to linings in the drainage ditches of the ash dewatering area, repairs to cooling tower basins, and other practices as may result from existing programs and implementation of the Groundwater Protection Plan. The Groundwater Protection Plan further describes water management facilities at NGS, their inspections and monitoring, emergency contingency plans, and the closure and post-closure care planning and reporting efforts. These activities are coordinated with the appropriate USEPA regulatory program. Included in these are clear protocols for sampling, analysis, and validation; specific water quality standards that can be used to trigger corrective actions; clear enforceable action levels based on federal standards; and reporting requirements.

Supplemental Appendix 2 to the Groundwater Protection Plan also details geologic factors and monitoring results at NGS. Water quality in the deep N-Aquifer wells has been regularly monitored since the mid-1990s. Background samples were collected in 1979 and 1981. With the exception of a temporary spike in well DW-2, TDS and sulfate have remained essentially at background levels, ranging from 100 to 160 mg/L and 10 to 45 mg/L, respectively. Well DW-2 was found to be leaking perched water below the surface casing and was rehabilitated in 1989 by installing a casing liner to a depth 660 feet bgs. Following the installation of the casing liner, TDS and sulfate concentrations returned to background levels (**Appendix 1B**). There is no evidence of a long-term increase in TDS concentrations in the deep wells, either from plant operations or from Lake Powell.

N-Aquifer samples at NGS also indicate concentrations of nitrate-nitrogen and fluoride are relatively low, and are less than the USEPA Maximum Contaminant Levels for drinking water (10 mg/L and 4 mg/L, respectively) (**Appendix 1B**). Nitrate levels generally are less than 3 mg/L; fluoride levels generally are less than 1 mg/L. Recent (2011–2012) concentrations of trace elements, including arsenic, barium, cadmium, chromium, lead, and selenium are less than the drinking water Maximum Contaminant Levels, and are below appropriate laboratory detection levels in the majority of samples. For example, the Maximum Contaminant Level for arsenic is 0.1 mg/L, and concentrations in N-Aquifer samples from NGS range from less than 0.002 mg/L to 0.0062 mg/L. Selenium concentrations are all below the 0.002 mg/L detection limit, much less than the selenium Maximum Contaminant Level of 0.05 mg/L. Mercury concentrations are all below the 0.0002 mg/L detection limit, much less than the mercury Maximum Contaminant Level of 0.002 mg/L.

3.7.3.2.2 Surface Water Features and Management at NGS

3.7.3.2.2.1 On-site Configuration

No groundwater supplies are used at NGS. NGS withdraws all of its water supply from Lake Powell through its pump station and associated pipeline. NGS has an annual allocation of 34,100 acre-feet per year for consumptive use. Over the past 15 years, annual water use at NGS has varied from about 26,000 up to 29,000 acre-feet per year.

The only natural surface water feature within or near the plant perimeter is a sandy, ephemeral tributary to Antelope Canyon. This passes through the area east of the main plant facilities, and about one-third of a mile west of the dry ash disposal site. No flow records are available for the tributary, and it flows only rarely in response to substantial rainfall. Still smaller ephemeral side-branches occur along the southern edge of the dry ash disposal site, but are isolated from it by bedrock outcrops, an engineered embankment with a bedrock foundation, and runoff retention berms on nearby soil surfaces. Other surface water components and related management at or near the NGS (**Appendix 1B**) consist of:

- NGS make-up water intake and pipeline from Lake Powell;
- On-site storage ponds and fluid routing fixtures (piping, ditches) involved in storing and recycling water used in plant activities; and
- Stormwater collection and detention structures (ditches, ponds); and
- Ash disposal site surface run-on and run-off controls as required by the CCR rule (40 CFR Part 257.81)

Monitoring and inspections of the water management facilities, which includes the public water system, are regularly carried out in conformance with NGS environmental programs and applicable federal rules and regulations (e.g., Safe Drinking Water Act). Contingency plans reflect pond capacity thresholds or alert levels, and triggers involve fluid management responses, communications and reporting protocols, staff assignments, and documentation of all analyses, repairs and training. Additional descriptions of plant facilities and activities at NGS are presented in the Operation and Maintenance Plan (**Appendix 1B**), and in the companion groundwater description for the plant. By the proposed project start in 2019, SRP will have designed run-on and runoff controls for the ash disposal landfill incorporating the required design storm (e.g., a 25-year, 24-hour event); will have obtained plan certification from a qualified registered Professional Engineer; and will have constructed the surface water controls in compliance with CCR regulations.

3.7.3.2.2.2 Lake Powell and River Water Quality

Baseline water quality conditions for Lake Powell, the San Juan River, and the Colorado River upstream and downstream of the reservoir have been summarized from available state and federal data, and from project-specific studies conducted for the respective ERA (Ramboll Environ 2016a,b,c,e). Project specific studies emphasized several geographic extents, including a 20-km radius around the NGS, a 150-km radius, and several river reaches of interest (**Figure 3.7-1**). The NGS Sampling Investigation Report indicates that concentrations of key Constituents of Potential Ecological Concern are consistent with or below background concentrations for the area within 150 km around the NGS and within the State of Arizona (Ramboll Environ 2016a). More water quality data for the Colorado River, San Juan River, and Lake Powell in the overall surface water study area are included in **Appendix WR-8** and the ERA documentation.

With respect to total metals analysis, the concentrations observed for many constituents in Lake Powell are similar to those seen in the Colorado River (Ramboll Environ 2016e). There are some exceptions among total metals, such as aluminum, antimony, cobalt, iron, and thallium. These were detected in the lake samples but not in the river samples. Also the total concentrations of copper, lead, manganese vanadium, and zinc were noted to be a factor of five (or more) higher in Lake Powell than the Colorado River. No total metals were identified with higher concentrations in the Colorado River compared to Lake Powell. Importantly, there were no particularly significant differences noted that may not exist in any natural environment (Ramboll Environ 2016e).

With respect to dissolved metals, data indicate that maximum concentrations for many constituents are consistent between Lake Powell and the Colorado River. There are some exceptions, such as dissolved antimony, beryllium, cadmium, chromium, cobalt, lead, manganese, silver, and thallium, which were detected in dissolved phase in Lake Powell but not in the Colorado River. Dissolved aluminum, vanadium, and zinc had slightly higher concentrations in Lake Powell compared to the Colorado River. Importantly, similar to the total metals, overall dissolved concentrations are relatively similar between the water-bodies, and there are no particularly significant differences noted that may not exist in any natural environment (Ramboll Environ 2016e). Within the 20-km radius study area around the NGS (**Figure 3.7-6**), surface water resources consist of Lake Powell, its local tributary Navajo Creek, and the Colorado River extending to slightly below Lees Ferry (downstream of Glen Canyon Dam). **Table 3.7-7** summarizes concentrations of selected water quality constituents within Lake Powell and its nearby major tributaries (Colorado River, San Juan River). In the table below, sampling stations within the 20-km radius study area include Padre Bay, Lone Rock Beach, Stateline Marina, Antelope Point Marina, and the Colorado River at Lees Ferry (**Figure 3.7-6**). More inclusive water quality information for the Colorado River, San Juan River, and Lake Powell in the overall study area is included in **Appendix WR-8**.

3.7.3.3 Proposed Kayenta Mine Complex

3.7.3.3.1 Groundwater at the Proposed KMC

The deep aquifer systems of interest to this EIS are the D- and N-Aquifers. These aquifers supply water to Navajo and Hopi communities and the proposed KMC. In the overall groundwater study area, these aquifers also supply water to numerous windmill-powered wells for stock watering. The extent and configuration of these aquifer systems are further illustrated on figures in **Appendix WR-6**.

In the proposed KMC area, the N-Aquifer is the primary source of water to various users. In addition, the D-Aquifer is estimated to have historically contributed approximately 130 acre-feet per year to the total mine water supply (OSMRE 2011a). Currently the mine withdraws groundwater from seven wells that penetrate through the D-Aquifer to the N-Aquifer. Until recently, eight wells were used, but one (NAV5) that was not being used has been plugged to prevent downward movement of poorer quality water from the D-Aquifer to the N-Aquifer. As of September 2015, there were two wells (NAV4 and NAV7) that were open to both the D- and N-Aquifers at the proposed KMC. Migration of D-Aquifer water to the N-Aquifer through the wellbores at these locations has the potential to impact N-Aquifer water quality. This concern is further addressed in the Environmental Consequences section. Based on the issue, PWCC has modified these two wells to minimize the inflow of water from the D-Aquifer. NAV4 has been rehabilitated, and NAV7 is completely reclaimed and unusable. Under the Proposed Action or any alternative, there will be no open D-Aquifer zones in PWCC pumping wells.

3.7.3.3.1.1 N-Aquifer

The N-Aquifer includes the Navajo Sandstone, and deeper sandstones of the Kayenta Formation, and the Lukachukai member of the Wingate Formation (**Figure 3.7-4**). Drilling records from installation of the PWCC N-Aquifer supply wells in the coal lease areas indicate that the top of the Navajo Sandstone occurs at depths ranging from 2,330 to 2,990 feet bgs. As mentioned previously, the N-Aquifer generally is separated from the overlying D-Aquifer by the Carmel Formation. Other formations above the N-Aquifer, as listed previously and depicted on **Figure 3.7-4**, separate it from other mining activities near the land surface.

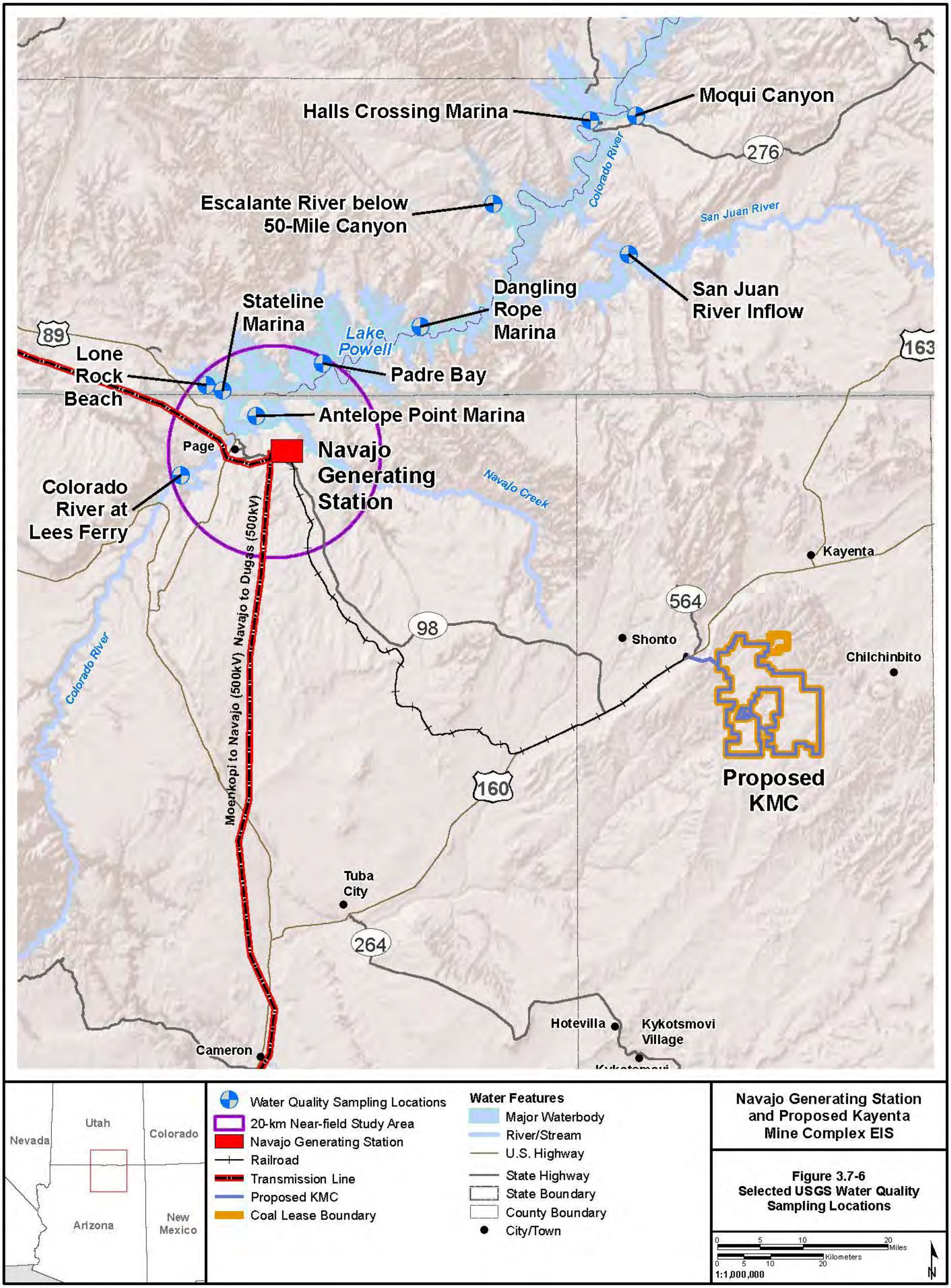

Figure 3.7-6
Selected USGS Water Quality Sampling Locations

Table 3.7-7 Average USGS Water and Lakebed Concentrations for Selected Constituents, Lake Powell and Selected Tributaries

Lake Powell Sites[1, 2]				
Marinas	**Halls Crossing (M2)**	**Dangling Rope (M3)**	**Antelope Point (M5)**	**Stateline (M6)**
Arsenic (D), water, µg/l	1.5	1.5	1.6	1.7
Mercury (D), water, µg/l	0.0005	0.0007	0.0006	0.0007
Selenium (D), water, µg/l	1.3	1.5	1.9	2.0
pH, water, standard units [3]	8.11 – 8.86	7.88 – 8.54	8.15 – 8.38	8.35 – 8.40
Arsenic (T), lakebed, µg/g	2.6	2.8	9.6	2.0
Mercury (T), lakebed, µg/g	0.002	0.0054	0.050	0.0033
Selenium (T), lakebed, µg/g	<0.6	0.7	1.0	<0.3
High Use Sites	**Moqui Canyon (HU5)**	**Escalante River at 50-mile Canyon (HU7)**	**Padre Bay (HU9)**	**Lone Rock Beach (HU11)**
Arsenic (D), water, µg/l	1.5	1.5	1.5	1.6
Mercury (D), water, µg/l	0.0004	0.0006	0.0006	0.0005
Selenium (D), water, µg/l	1.5	1.2	1.7	2.0
pH, water, standard units [3]	8.07 – 8.88	7.89 – 8.60	7.95 – 8.49	8.32 – 8.46
Arsenic (T), lakebed, µg/g	3.0	12.0	3.8	1.4
Mercury (T), lakebed, µg/g	0.0086	0.027	0.0073	0.0038
Selenium (T), lakebed, µg/g	0.8	0.6	0.6	0.4
River Sites[1,2]				
	San Juan River Inflow	**Colorado River below Big Drop #3 Rapids**	**Colorado River above Dark Canyon**	**Colorado River at Lees Ferry**
Arsenic (D), water, µg/l	1.2	1.6	1.8	1.4
Mercury (D), water, µg/l	0.0007	ND	ND	ND
Selenium (D), water, µg/l	1.1	3.1	3.2	1.7
pH, water, standard units[3]	8.40 – 8.46	7.32 – 8.83	7.42 – 8.84	7.90 – 8.30

[1] Values are arithmetic averages of multiple field samples and/or laboratory splits.

[2] For arsenic, mercury, and selenium, the aquatic use chronic standards are as follows (Arizona Department of Environmental Quality 2016; NNEPA 2008; Utah Department of Environmental Quality-Division of Water Quality [UDEQ-DWR] 2016):

- Arsenic, dissolved, micrograms per liter: 150 (NNEPA); 150 (Utah); 150 (Arizona)
- Mercury, dissolved, micrograms per liter: 0.001 (NNEPA); 0.012 (Utah); 0.01 (Arizona)
- Selenium, dissolved (D) or total (T): micrograms per liter: 2.0 D (NNEPA); 4.6 D (Utah); 2.0 T (Arizona)

[3] Values for pH are shown as ranges from discrete measurements.

D: dissolved fraction; T: total recoverable; µg/L: micrograms per liter; µg/g: micrograms per gram; < signifies “less than”; ND: not detected.

Source: Hart et al. 2012; Schonauer et al. 2014; USGS-NWIS 2015; UDEQ 2015.

Figure 3.7-7 shows values of N-Aquifer transmissivities on the proposed KMC. Transmissivity is a hydraulic property that describes the amount of water flowing through a unit width of the aquifer for a unit change in head. It is a measure of an aquifer's ability to transmit groundwater. In **Figure 3.7-7**, N-Aquifer transmissivities are fairly similar (same order of magnitude), indicating that the aquifer is fairly uniform within the leasehold.

On the lease areas, PWCC monitors water levels in the N-Aquifer supply wells and associated observation wells. Historically there have been eight supply wells, numbered NAV2 through NAV9 (**Appendix WR-5, Figure WR-5.3**) and observation wells NAV3OBS and NAV6OBS. After cessation of coal slurry pipeline operations at the former Black Mesa Mine at the end of 2005, water levels in NAV3OBS rose from a depth of 1,183.7 feet bgs to 978.4 feet bgs by the end of 2011. This represents a recovery of 205.3 feet from the maximum drawdown of 453.7 feet, or about 42 percent (OSMRE 2012). Recent static water levels in NAV3OBS are about 985 feet bgs (PWCC 2014). Similarly, at PWCC monitoring well NAV6OBS, water levels rose about 136.0 feet from the maximum drawdown of 433.5 feet bgs, a recovery of about 31 percent as of the end of 2011 (OSMRE 2012). Recent static water levels in the NAV6 vicinity are about 1,181 feet bgs (PWCC 2014).

Although water level recovery is occurring at NAV6OBS, the response is not as steady as at NAV3OBS. Observation well NAV6OBS is in stronger hydrologic connection to historical PWCC production well NAV5 (OSMRE 2012), (which has recently been abandoned). Differences in pumping history before and after the end of 2005 also affect the water levels. Prior to 2006, NAV3 was pumped at a higher rate than NAV6; after 2005, NAV6 was pumped at a higher rate than NAV3.

For PWCC NAV wells and associated observation wells in 2013, N-Aquifer static water level depths within the coal lease areas ranged from 730 feet bgs at NAV4, to 1,201 feet bgs at NAV6. The elevation (not depth) of the top of the N-Aquifer ranges from 3,914 feet at NAV7 to 4,279 feet at NAV6/6OBS. The amount of artesian head (height of water above the top of the N-Aquifer) was approximately 1,256 feet up through 2005 (using data from NAV wells 3, 4, 5, 6, and 9). Since coal slurry pipeline operations and related pumping withdrawals ceased in 2005, artesian head has increased an average of approximately 233 feet for the production wells, 162 feet for observation well NAV3OBS, and approximately160 feet for observation well NAV6OBS.

Through 2014, there remains at least 1,195 to 1,595 feet of artesian head (an average of 1,468 feet) above the N-Aquifer at the PWCC wells (PWCC 2012 et seq.). Substantial artesian head also occurs elsewhere within the confined N-Aquifer, as indicated in **Appendix WR-8, Figures WR-8.9** through **WR-8.12**, and decreases toward the confine/unconfined boundary. In wells that are outside the confined zone, water levels are at or below the top of the N-Aquifer. This also is reflected in the **Appendix WR-8** figures.

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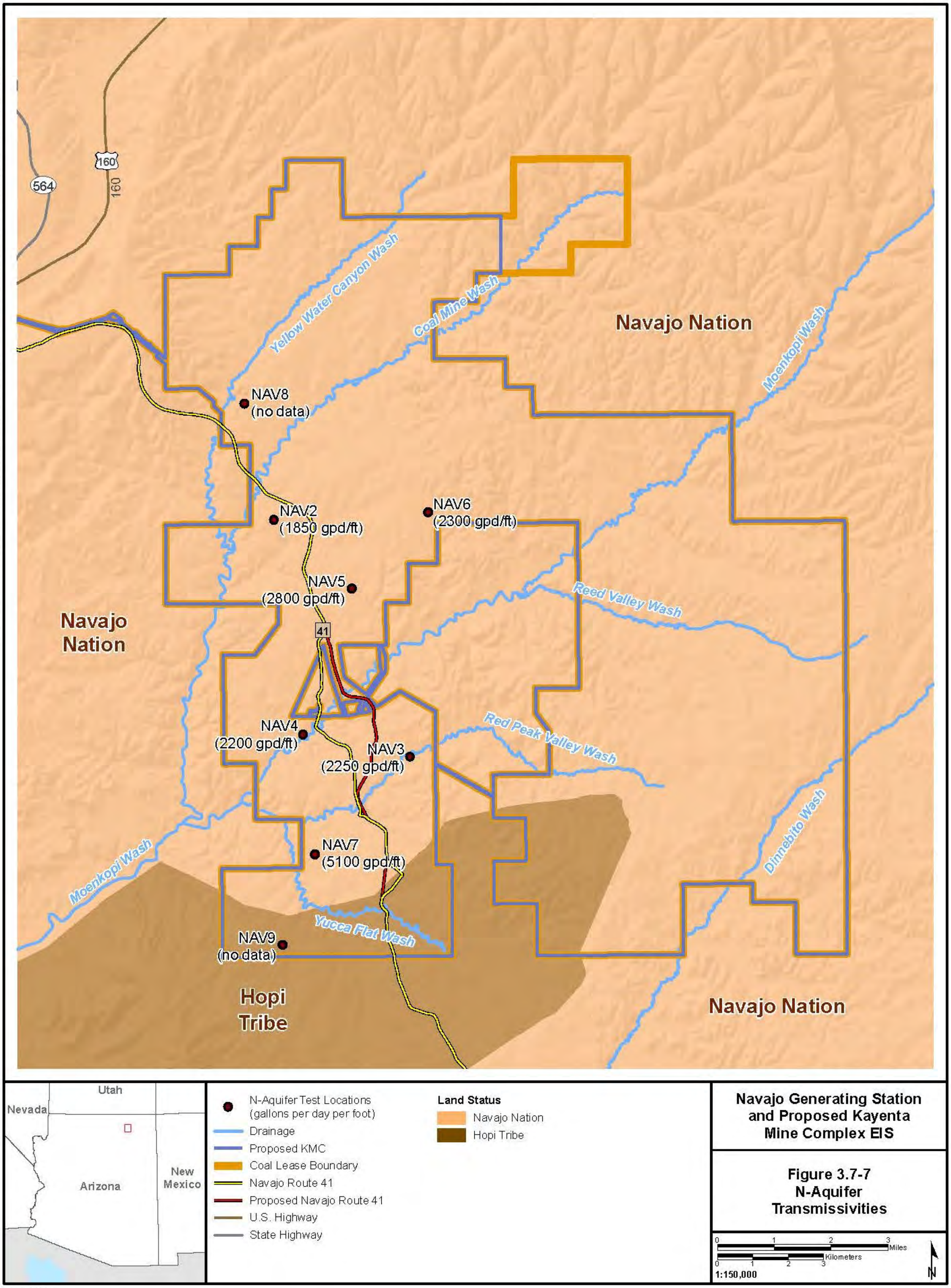

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Figure 3.7-7
N-Aquifer Transmissivities

7/20/2016

N-Aquifer Water Use

All mine withdrawals are from the confined portion of the aquifer (USGS 2015). Historical mine withdrawals are provided in **Appendix WR-7, Table WR-7.1**. Maximum N-Aquifer withdrawals for the mine were 4,740 acre-feet in 1982. More recently in 2005, N-Aquifer water use at the mine was 4,480 acre-feet per year. That declined substantially in 2006 (to 1,200 acre-feet per year) with the end of coal slurry pipeline operations that supplied the Mojave Power Plant. The mean annual pumping for 2006 through 2012 was about 1,273 acre-feet per year. Recent pumping from all mine wells has varied annually, and has ranged from about 1,200 to 1,600 acre-feet per year. For example, mine withdrawals were 1,370 acre-feet for Calendar Year 2012, and 1,171 acre-feet in Calendar Year 2010 (Macy and Truini 2016; Macy et al. 2012). More recent withdrawals reported by PWCC were 1,464 acre-feet in 2013, and 1,584 acre-feet in 2014. The variations are due to dust suppression uses, well maintenance and sampling needs, and other factors. In 2014, PWCC operated eight water supply wells on its leasehold. These wells and their 2014 production volumes are given in **Table 3.7-8**. PWCC has recently plugged Well NAV 5 and shifted its production to other NAV wells.

Table 3.7-8 PWCC 2014 Well Withdrawals

Well	acre-feet
NAV2	897.5
NAV3	16.3
NAV4	38.9
NAV5	81.1
NAV6	244.9
NAV7	46.4
NAV8	225.8
NAV9	33.0
Total	1,583.9

Future mine withdrawals are projected to average about 1,200 acre-feet per year through 2044, decline to 500 acre-feet per year through 2047 and then continue at 100 acre-feet per year from 2048 through 2057 before ceasing altogether. Water uses at the mine include domestic supply and sanitation, equipment and coal-processing operations and maintenance, dust suppression (as required by federal regulations), and providing water to nearby tribal residents. The PWCC leases and approved Surface Mining Control and Reclamation Act permit specify monitoring and maintenance of the N-Aquifer wells (OSMRE 2011a).

Recent estimates of N-Aquifer pumping by 27 tribal centers in the study area indicate that from 2008 through 2012, between 2,500 and 3,100 acre-feet per year were withdrawn for community uses (Macy 2014). Historic PWCC and community pumping volumes are tabulated in **Appendix WR-7, Table WR-7.1**.

N-Aquifer Water Quality

Recent water quality data for individual N-Aquifer wells at the Kayenta Mine are summarized in **Appendix WR-7, Tables WR-7.2** through **WR-7.10**. Recent (2010-2014) water quality summaries for the N-Aquifer wells on the coal leasehold indicate TDS concentrations across all the N-Aquifer wells in the coal lease area ranged from 80 to 315 mg/L, with average and median values of 151 and 130 mg/L, respectively. Sulfate concentrations ranged from about 1.4 to 127 mg/L, with average and median values of 22.4 and 8.7 mg/L, respectively (**Appendix WR-7, Table WR-7.2**). These concentrations are substantially lower than D-Aquifer values tabulated below. Total cadmium was only detected in 1 out of 74 sample analyses, and that value (6 µg/L at NAV7 in January 2013) was 1 µg/L above the drinking water criterion. This result was likely a laboratory error; analysis of a subsequent 2013 sample indicated a total cadmium concentration below the detection level of 0.1 µg/L (PWCC 2014). Total lead was below detection levels in 66 of 76 samples (87 percent) but did exceed drinking water criteria (15 µg/L expressed as total concentration) in one sample at NAV2. All other constituents were within drinking water criteria except pH. Historically all of the NAV wells except NAV8 have produced water with typical pH values greater than the recommended secondary drinking water maximum (8.5 standard units). Similar pH conditions also occur at other supply wells in the study region.

Areas of potential D-Aquifer leakage to the N-Aquifer across the Carmel Formation are depicted in **Appendix WR-6, Figure WR-6.4**. They occur well south of the leasehold (Truini and Macy 2006). The regional continuity of the Carmel Formation is depicted in **Appendix WR-6, Figure WR-6.5**. The formation thins southwest of Pinon, and generally thickens near the coal lease area. In combination with NAV well water quality monitoring results (**Appendix WR-7**), it can be concluded that D-Aquifer communication with the N-Aquifer in the leasehold has resulted in negligible water quality effects in the PWCC NAV wells and has not impaired N-Aquifer water quality. Little or no changes have occurred to N-Aquifer water quality since the onset of mine-related pumping, and the water is well within applicable water quality standards.

The potential for induced leakage from the D-Aquifer due to groundwater pumping in the N-Aquifer is less in the area where the N-Aquifer is confined by the Carmel Formation than in areas where the Carmel Formation is thin or sandy. The thickness and lithology of the Carmel Formation are factors influencing groundwater leakage between the aquifers. Areas where the Carmel Formation is less than 120 feet thick coincide with areas where water from the overlying D-Aquifer has historically (over thousands of years) mixed with underlying N-Aquifer water (Truini and Longsworth 2003; Truini and Macy 2006). The Carmel Formation is thicker than that in the lease area, ranging from 140 to 170 feet thick in NAV well drilling logs. Based on historical and recent N-Aquifer water quality results from the coal lease area, water quality effects from the D-Aquifer leakage are negligible in the PWCC NAV wells.

3.7.3.3.1.2 D-Aquifer

The D-Aquifer includes the Dakota Sandstone, the water-bearing portions of the Morrison Formation, and the Cow Springs Sandstone. In the Kayenta Mine leasehold area, the thickness is approximately 1,000 feet. The D-Aquifer is overlain by the Mancos Shale and is confined within the coal lease areas, as well as over most of the cumulative study area (Arizona Department of Water Resources 1989).

Groundwater modeling for PWCC has indicated that the greatest change in D-Aquifer water levels are within the PWCC leasehold, where incidental drawdown due to mine withdrawals has lowered water levels by about 150 feet (Tetra Tech 2015a). Outside the leasehold no significant change in groundwater flow direction has occurred due to this drawdown.

D-Aquifer Hydraulic Parameters and Well Yields

Regionally, average D-Aquifer specific yield was estimated to be 0.015 based upon core samples adjusted to compensate for the non-water-bearing units included in the thickness (Cooley et al. 1969). The D-Aquifer is confined beneath the Kayenta Mine, and the calibrated specific storage coefficient used in the PWCC groundwater flow model is 3×10^{-7} per foot. Based on regional specific capacity data from 45 outlying wells reportedly screened in one or more D-Aquifer units, horizontal hydraulic conductivity ranges from 0.004 to 2 feet/day (HDR Engineering, Inc. 2003). These hydraulic conductivity values are summarized in **Table 3.7-9**.

Table 3.7-9 D-Aquifer Hydraulic Conductivity

Parameter	Values (feet/day)
No. of Tests	45
Average	0.27
Median	0.11
Minimum	0.004
Maximum	2.04

Source: HDR Engineering, Inc. 2003.

These values are indicative of the low permeability nature of the formations comprising the D-Aquifer system. As discussed above for the N-Aquifer, additional information about the D-Aquifer is presented in **Appendix WR-6**. Potential areas of D-Aquifer leakage to the N-Aquifer are indicated in **Appendix WR-6, Figure WR-6.4** from USGS investigations. Also based on USGS investigations, the continuity of the Carmel Formation (which isolates the D-Aquifer from the N-Aquifer under the coal leasehold) is depicted in **Appendix WR-6, Figure WR-6.5**.

Well yields from the D-Aquifer are not well documented. Most wells are powered by windmills and are used for livestock watering purposes with withdrawals of less than 0.5 acre-feet per year. Some community wells may produce up to 100 gallons per minute (gpm) (Tetra Tech 2011).

<u>D-Aquifer Water Use</u>

Water from wells in the D-Aquifer on Black Mesa primarily is used for livestock watering, with some incidental industrial use by PWCC on the Kayenta Mine leasehold and also some community uses. Three of the eight PWCC water supply wells were perforated in both the D- and N-Aquifers. Historically (2005 and before) PWCC estimated that up 130 acre-feet per year was extracted from the D-Aquifer by these wells, out of roughly 4,500 acre-feet per year that were pumped by PWCC in 2005 and before. One well (NAV 5) has been abandoned, leaving two wells (NAV 4 and 7) perforated in the D-Aquifer. These also are being modified to reduce influence from the D-Aquifer. As noted previously, PWCC is presently modifying the proposed KMC water supply system to eliminate withdrawals from the D-Aquifer.

Based on USGS information for screened or open intervals in monitored wells in the study area (Macy and Unema 2014), several other locations are open to the D-Aquifer (or other zones) and likely withdraw from them as well as the N-Aquifer. These include Forest Lake NTUA1 (4T-523), Kykotsmovi PM1, Marsh Pass (8T-522), Howell Mesa (3K-311), and Black Mesa Observation Well 1 (8T-537).

<u>D-Aquifer Water Quality</u>

Groundwater quality in the D-Aquifer is marginal to unsuitable for domestic use, although it may be acceptable for other uses. TDS concentrations range from 190 to 4,410 mg/L, generally exceeding the recommended limit of 500 mg/L for drinking water. Fluoride concentrations range from 0.2 to 9.0 mg/L and often exceed the maximum contaminant level concentration of 4 mg/L. Water quality improves slightly in the southern portion of the aquifer (Arizona Department of Water Resources 1989).

Water quality data for D-Aquifer wells are limited to 43 wells with sampling occurring between 1950 and 1999 (USGS 2015). Locations of the wells are shown on **Figure 3.7-8**. Data are summarized in **Table 3.7-10**.

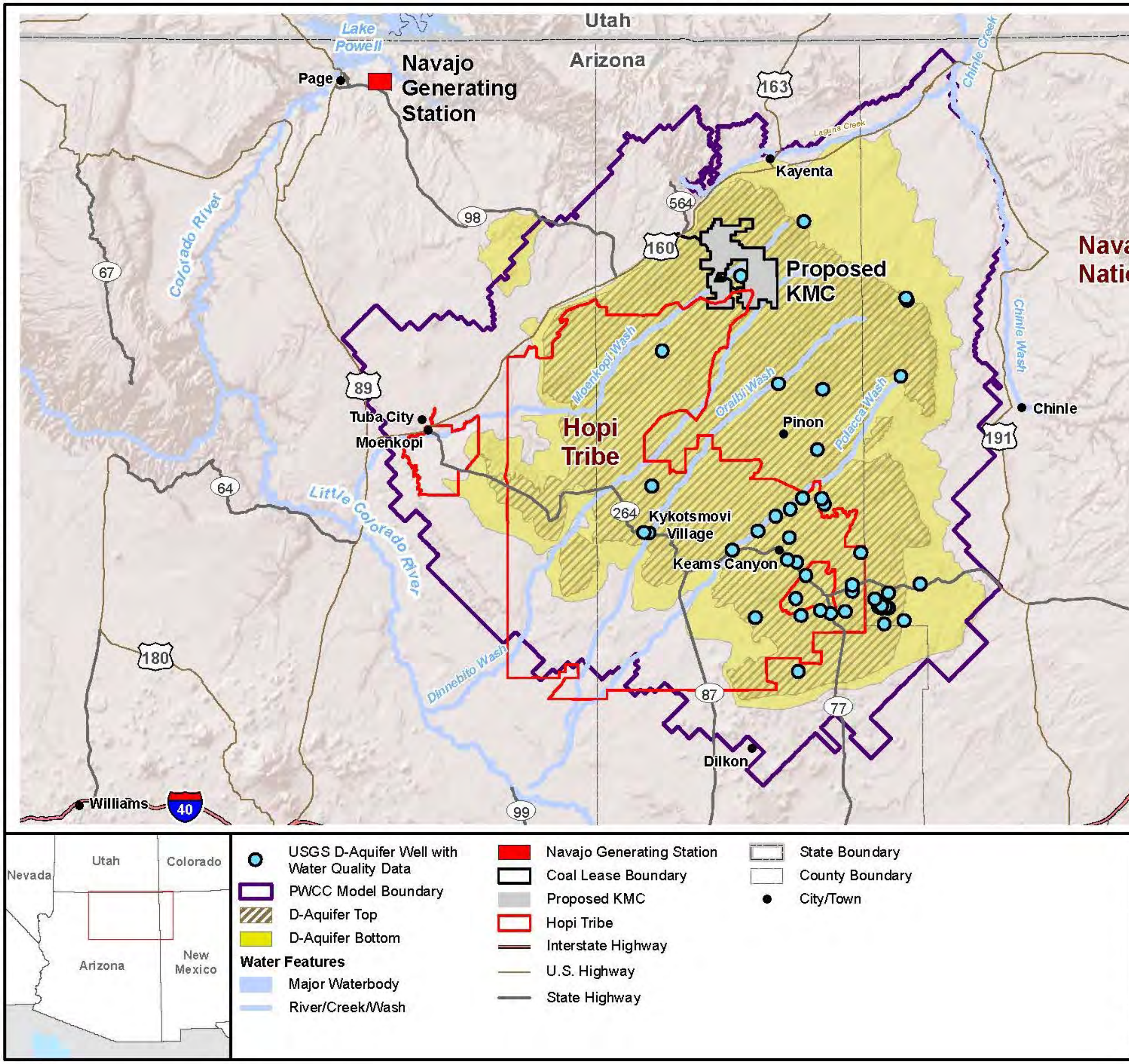

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Figure 3.7-8
D-Aquifer
Water Quality Wells

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Table 3.7-10 D-Aquifer Water Quality

Parameter[1]	Sodium (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Arsenic (mg/L)	TDS (mg/L)
No. of samples	21	43	42	4	7
Average	198	57	376	0	902
Maximum	650	260	1,700	0.009	2,120
Minimum	5.7	4.4	9	0.001	148
Drinking Water Maximum Contaminant Levels	None listed	250	250	0.01	500

[1] Drinking water standards are further explained in tables presented in **Appendix WR-7**.

Source: USGS 2015.

There is a regional concern about the exchange of groundwater from the D-Aquifer to the N-Aquifer, and consequential adverse effects on N-Aquifer water quality. Groundwater leakage from the D-Aquifer through the Carmel Formation to the N-Aquifer has been occurring naturally for thousands of years (Truini and Macy 2006). **Appendix WR-6, Figures WR-6.4** and **WR-6.5** indicate the areas of natural anticipated leakage between the aquifers, and the continuity of the intervening Carmel Formation across the project vicinity, respectively. PWCC is currently rehabilitating selected N-Aquifer (“NAV”) wells within the coal leaseholds to eliminate contributions from the D-Aquifer. Flow between the aquifers along PWCC wellbores will be eliminated prior to 2020. In the leasehold area, little or no effects on N-Aquifer water quality have resulted from mine-related pumping.

3.7.3.3.1.3 D- and N-Aquifer Springs

The USGS undertook a study to identify and characterize springs identified by various methods (Leake et al. 2016). A total of 104 springs characterized as “likely” were identified as emanating from D- and N-Aquifer stratigraphic units. With the exception of the four USGS monitored springs, individual sites were not visited and no flow data are available. To facilitate the discussion of impacts of proposed mine-related pumping on springs and seeps, these features were grouped into major areas (“A” through “J”) based on their geographic and hydrogeologic similarity. Further discussion of this is presented in the Environmental Consequences section. Additional spring information is presented in **Appendix WR-10.**

3.7.3.3.1.4 Wepo Formation

The Wepo Formation is the geologic unit at or near the land surface over much of Black Mesa. It crops out in the northern portions of the mesa, where it is exposed over approximately 1,270 square miles (Peirce et al. 1970). It consists of several bedrock types, dominantly including interbedded shale, siltstone, sandstone and coal that erode to form steep slopes (Nations et al. 2000). The upper Wepo Formation is the source of coal mined by PWCC. The formation contains the highest quality coal on Black Mesa as well as the largest minable reserves (Peirce et al. 1970).

The top of Black Mesa is an erosional surface, and the thickness of the Wepo Formation in a particular locale depends on geologic structure and the extent of downcutting by streams such as Moenkopi, Dinnebito, and Oraibi Wash. Additional geologic characteristics of the Wepo Formation are discussed in **Appendix WR-5**. The formation consists of interbedded sandstones, mudstones and claystones, coal, and carbonaceous shales. These sedimentary rocks were formed in several depositional environments as described in the Appendix. Rock layers are discontinuous, and generally have limited spatial extent. The thickest and most continuous coal seams are in the upper half of the formation, in the northern part of the mesa where the upper half has not been completely eroded away. Individual coal seams may extend laterally for hundreds or thousands of feet, but eventually thin out. Other seams usually occur within a few feet vertically. This is generally depicted in **Appendix WR-5, Figures WR-5.1** and **WR-5.2**.

A combination of erosion or naturally burned coal seams limits the mineable reserves to detached, irregular areas or "islands" (Peirce et al. 1970). Northeastward across Black Mesa, the Wepo Formation thins and tongues into the overlying Yale Point Sandstone and into the underlying Toreva Formation (Repenning and Page 1956).

Arizona Department of Water Resources (2008) describes this unit as mainly unconfined, with perched water zones overlying relatively low-permeability coal, siltstones and mudstones. It has variable water levels, and is likely to have complex flow directions due to the occurrence of perched water-bearing zones (Arizona Department of Water Resources 2008). PWCC investigations indicate that confined conditions are more common in the leasehold. Some variations in Wepo Aquifer hydraulic characteristics within the leasehold are indicated on **Figure 3.7-9**.

These variations within the Wepo Formation have been investigated through aquifer tests by PWCC. Transmissivity is a measure of how much water can be transmitted horizontally through a saturated zone, for example, to a pumping well. The large range in transmissivities, and thus aquifer characteristics, within the Wepo Formation can be seen on **Figure 3.7-9** (PWCC 2012 et seq.). This further confirms the nature of the Wepo Formation as a highly variable aquifer. For example, transmissivity values within 2 or 3 miles range from 0.25 gallons per day (gpd) per foot at Site 44 near the center of the leasehold, to 7 gpd per foot at Site 53, to 132 gpd per foot at Site 43. Similarly, at Site 62, the transmissivity is 0.1 gpd per foot, but 2 miles away it is 204 gpd per foot at Site 63. In contrast to N-Aquifer conditions (**Figure 3.7-7**), the Wepo values indicate a high degree of variation in hydraulic characteristics within fairly short distances. This corresponds to the isolated, perched nature of water-bearing zones in the Wepo Formation, and to differences in their geologic characteristics.

Since most of the transmissivity values are fairly low [less than 100 gpd per foot, with a median of 40 gpd per foot (OSMRE 2011b)], the water-yielding nature of the Wepo Formation is limited in the mine area. Conceptually this is further supported by the discontinuous extents of geologic layers represented in **Figure 3.7-10**. On **Figure 3.7-10**, Facies A and C zones consist of more porous sandstones, Facies D zones are isolating deposits of claystone and mudstone, and Facies E is coal and carbonaceous shale. Additional geologic discussion is presented in **Appendix WR-5**. The depositional framework consists of sheets or ribbons of sandstones that are encased in an interbedded sequence of claystone, mudstone, and coal (Carr 1991). Laterally, the Facies A sandstones range from a few feet up to about three or four miles in extent (Carr 1991). Aquifer continuity is restricted by the surrounding low-permeability Facies D materials. The most laterally continuous zones are the coals and carbonaceous shales (Facies E). These form beds of less than a foot up to about 15 feet thick, and extend from less than 0.6 to over 8 miles laterally. The coal beds typically pinch out, grade into carbonaceous shale, or end abruptly at sandstone deposits (Facies A) (Carr 1990). They do not form significant aquifer zones. Based on transmissivity and geologic characteristics, the Wepo Formation forms isolated water-bearing zones within the coal leasehold. These provide little or no hydrologic connection to different locations beyond the leasehold. The formation is an inconsistent source of water to wells, and springflows vary with local conditions in source areas bounded by canyons and washes.

Water levels in individual Wepo Formation monitoring wells (WEPO series wells) have been recorded over time by PWCC. These locations are depicted in **Appendix WR-5**, **Figure WR-5.3**. **Appendix WR-5, Tables WR-5.1** and **WR-5.2** indicate changes in water levels within these wells over time including recent years. Many of the water levels have been rising slightly (levels shallower than in previous years, however most of the wells have fairly small fluctuations, on the order of 1 foot or less since 2005 (**Appendix WR-5, Table WR-5.1**). Over time, there are several primary reasons for water level fluctuations in Wepo Formation monitoring wells. These mainly include: recharge associated with significant (and sometimes highly localized) precipitation events; extended dry periods; water quality sampling; and drainage to mine pits. Historically, other causes such as aquifer testing and residual drilling effects also contributed to water level variations in Wepo wells (PWCC 2012 et seq.).

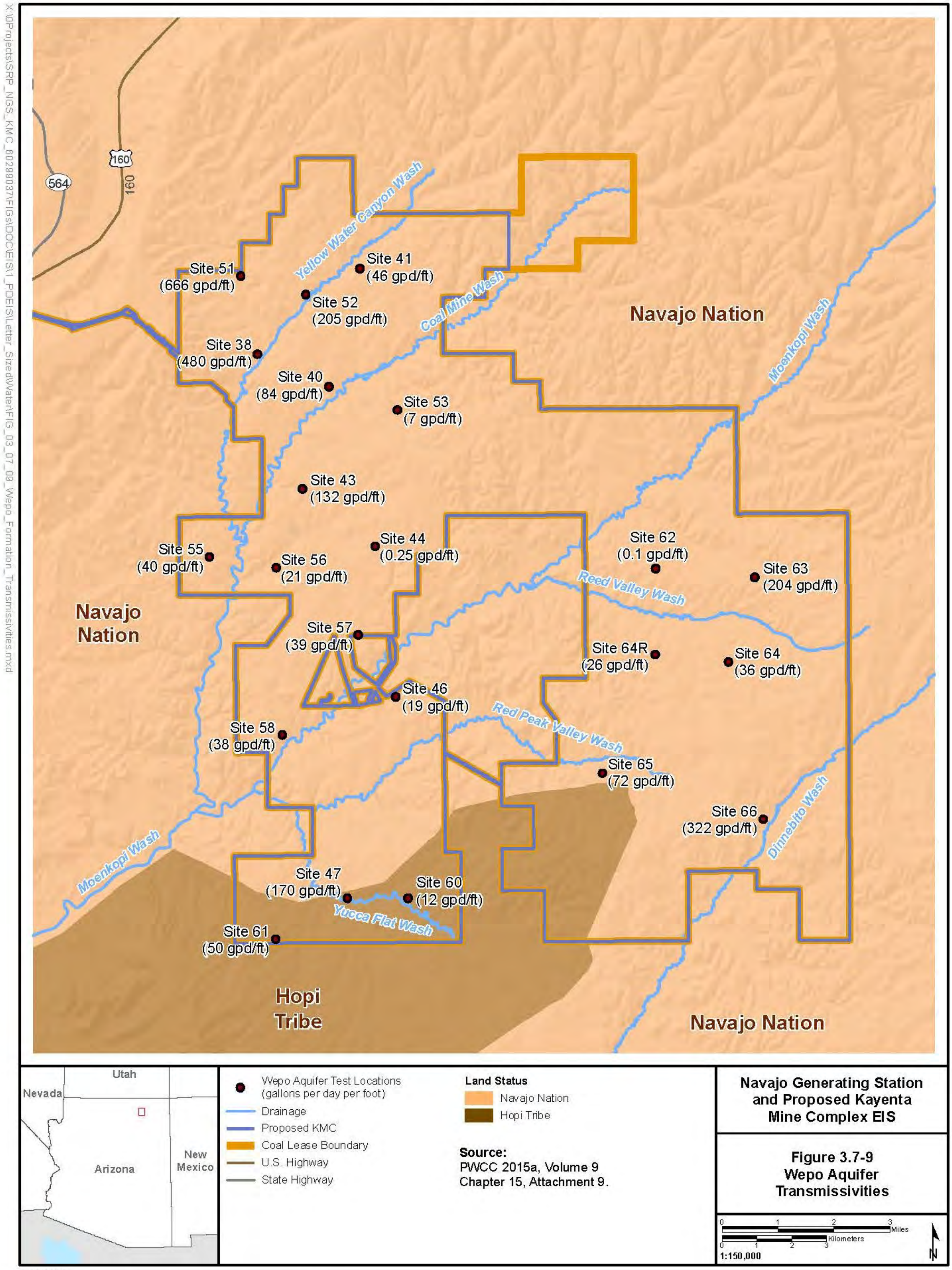
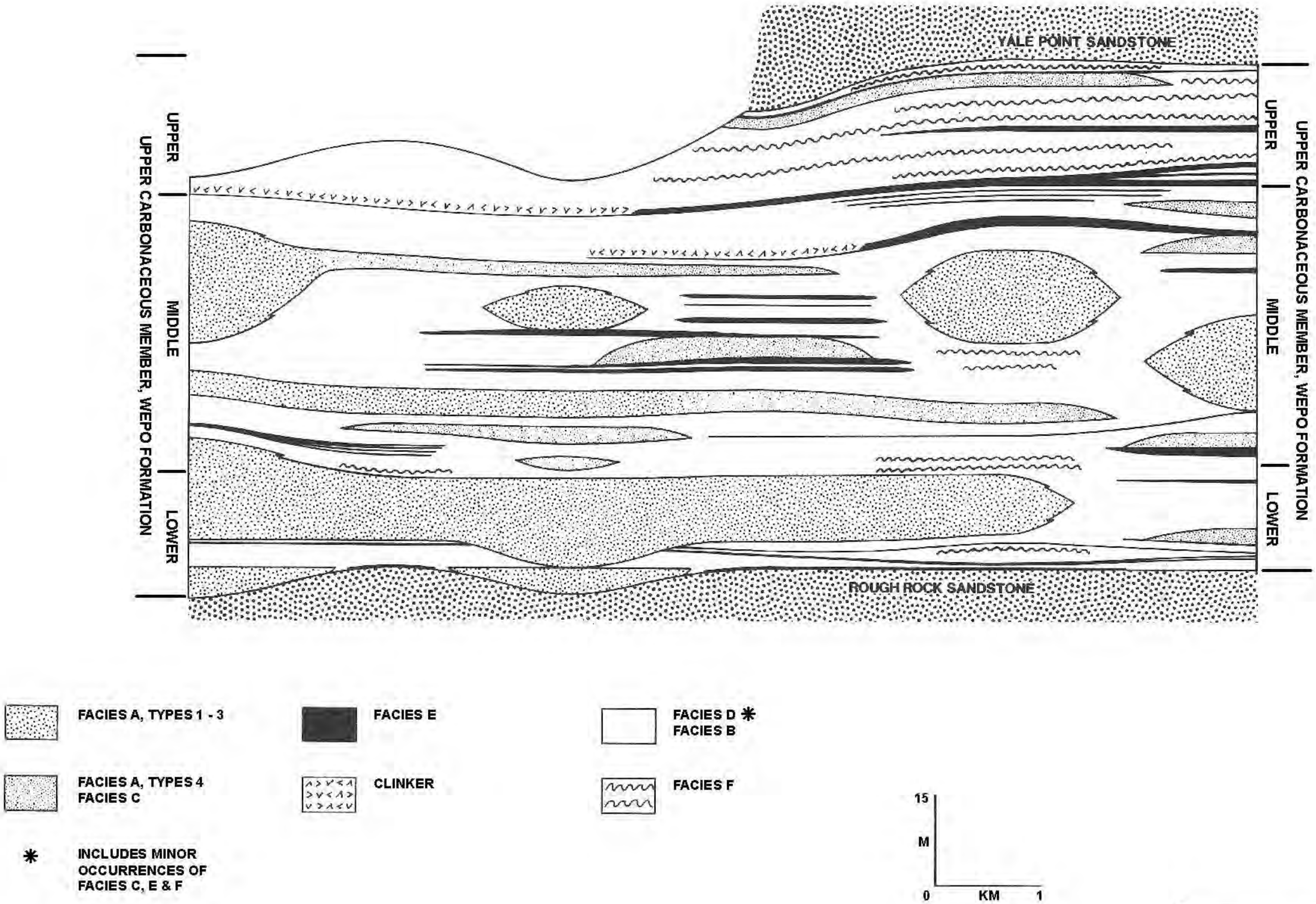


Figure 3.7-9
Wepo Aquifer Transmissivities



Source: Carr 1990

*Further explanation and details are provided in Appendix WR-5

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Figure 3.7-10
General Nature of the Wepo Formation

Although surface water quality standards for livestock watering do not apply to groundwater in the Wepo Formation or any other aquifer, sampling results have been compared to surface water standards simply as a source for comparison. None of the Wepo monitoring wells indicated exceedances of established tribal surface water quality criteria for livestock watering. General water quality classifications range from mixed sulfate to sodium bicarbonate types. A detailed discussion of water quality in the Wepo Formation is presented in **Appendix WR-5** and summarized in **Tables WR-5.3** through **WR-5.12**. Dissolved trace elements are generally at low concentrations or are undetected throughout the leasehold. Sulfate and bicarbonate concentrations vary, and sodium is typically a dominant constituent. The median background bicarbonate concentration is about 600 mg/L, and the median background sulfate concentration is about 170 mg/L. Higher sulfate and lower bicarbonate concentrations occur within smaller locales in the coal leasehold. The median background TDS concentration is about 860 mg/L, but higher values occur in some parts of the leasehold. Further information is presented in **Appendix WR-5**.

3.7.3.3.1.5 Alluvial Aquifer (Unconsolidated Stream Channel Sediments)

Sediment has been deposited within the channel of all of the major drainages on Black Mesa. These sediments consist of sand and gravel, silts, and clays that are initially transported from uplands by rainfall and runoff. They are then deposited, stored, and further transported through the stream networks by rising and falling flows, and known as stream-laid alluvial deposits. Shallow groundwater occurs within these deposits, forming relatively narrow, linear alluvial aquifers along the stream channels. These water-bearing zones interact with surface water flows, springs, and underlying bedrock aquifers. The alluvial aquifer is a link between streamflows and groundwater from underlying water-bearing bedrock. Water absorbed and released by the alluvium supports riparian vegetation and corresponding aquatic and wildlife habitats.

Bedrock that underlies the alluvium at upper elevations on Black Mesa consists mainly of rock units within the Wepo Formation. At progressively lower elevations toward the valley floors at Tuba City and elsewhere, the alluvium interacts with the Toreva Formation, the D-Aquifer, and the N-Aquifer based on their nearness to the land surface along streams. Where the N-Aquifer is unconfined (outside the confined zone, **Figure 3.7-3**), there is direct hydrologic communication between that bedrock aquifer and alluvial channel deposits. The alluvium is recharged by surface water infiltration and from groundwater flowing from saturated bedrock aquifer zones on the mesa and out on the valley floor. Within the coal permit areas, recharge to the alluvium from truncated saturated areas of the Wepo Formation help maintain the alluvial water levels during extended dry periods (OSMRE 2011a).

The alluvial deposits vary from coarse (gravel and sand) to fine (silts and clays) depending on the geologic nature of the surrounding landscape and how far the sediments are transported. Where the N-Aquifer is unconfined, alluvial textures are typically coarser, dominated by sands and gravels from the Navajo Formation and other coarse-textured bedrock. In the coal lease areas at higher elevations on the mesa, Wepo Formation characteristics create a broad variety of these alluvial grain-size distributions (or “textures”). On Black Mesa, all of the major washes in and near the coal leases (Yazzie Wash, Coal Mine Wash, Moenkopi Wash, Dinnebito Wash, Reed Valley Wash, Red Peak Valley Wash) have alluvial deposits along their channels. These deposits vary in their location and extent along the streams, in their thickness above bedrock, and in their textural, chemical, and hydrologic characteristics.

PWCC has constructed alluvial aquifer wells to monitor corresponding water levels and water quality data in accordance with regulatory requirements. Data have been collected and reported by PWCC since the 1980s. **Appendix WR-4**, **Figure WR-4.1** indicates locations of alluvial monitoring wells. During 1980, PWCC conducted detailed investigations (in accordance with Surface Mining Control and Reclamation Act regulations) to determine the potential occurrence of alluvial valley floors. Although alluvial valley floors were determined not to exist on or immediately adjacent to the Kayenta Mine, these studies also provided information about the thickness and saturation of alluvium through the use of seismic refraction surveys (OSMRE 2011a).

The uppermost headwater branches of all washes and tributaries contain little or no alluvial groundwater. In general, saturated thicknesses ranged from 3 to 34 feet in larger deposits at lower positions in canyons and valleys. The thinnest saturated alluvial thicknesses occurred in the upper reaches of the major washes, and the thickest occurred in the lower reaches (OSMRE 2011a). The greatest saturated cross-sectional areas were determined to be along lower Coal Mine Wash, lower Moenkopi Wash, and lower Dinnebito Wash (OSMRE 2011a). Records taken during alluvial well construction indicates that the deposits vary in both width and depth along any given wash, as well as from one wash to another. The sediment accumulations consist of poorly sorted materials (with mixed particles ranging in size from clays to cobbles), and also as thin beds of more sorted materials. In turn, these material variations influence the hydraulic properties of the alluvium, creating variable groundwater storage and movement properties from one location to another.

Transmissivity tests of alluvial aquifers were conducted in the alluvial well bores or in pits dug in the deposits (PWCC 2012 et seq.).These investigations measured the amount of water that can be transmitted horizontally within the saturated alluvial zone, for example to a pumping well. The results of these are indicated on **Figure 3.7-11**. In addition to the geologic variation indicated in well construction records, variations in hydraulic conditions in channel alluvium are evident from the different test values obtained along the washes. These results can vary an order of magnitude or more within the same wash (OSMRE 2011a). For example, alluvial transmissivity values along Yellow Water Canyon Wash in the northwest part of the leasehold vary from 37 gpd per foot at Site 72, to 3,508 gpd per foot at Site 75 about 1 mile downstream. Similar variations can be seen along Coal Mine Wash, Moenkopi Wash, and elsewhere in the leasehold. This attests to the variable nature of alluvial aquifer zones on the leasehold. In particular, it can be seen from **Figure 3.7-11** that the transmissivity of the alluvial deposits does not necessarily increase downstream.

Water level changes in the alluvium result from temporal changes in evaporation; variable uptake and transpiration by vegetation along the washes; changing runoff conditions and resulting changes in streamflow; and from contributions at springs and connected bedrock aquifers. These are primarily natural variations that occur throughout the region. In the coal lease areas, seepage from ponds or drawdown near mined areas also affect alluvial water levels. PWCC routinely monitors water levels in the alluvial monitoring wells. Recent data indicate water level changes in these wells typically rise or fall between less than 1 foot to about 3 feet. A few wells have greater fluctuations, but most changes are less than about 1.5 feet. The direction of change (either rising or falling) changes from year-to-year. For example, water levels generally fell in 2009 compared to 2008, but generally rose in 2013 compared to 2012 (**Appendix WR-4**, **Table WR-4.1**). Climatic variations (temperature, rainfall) and related evapotranspiration rates contribute to these effects. Further discussion of vegetation is presented in EIS Section 3.8, and climatic factors are discussed in EIS Sections 3.1 and 3.2.

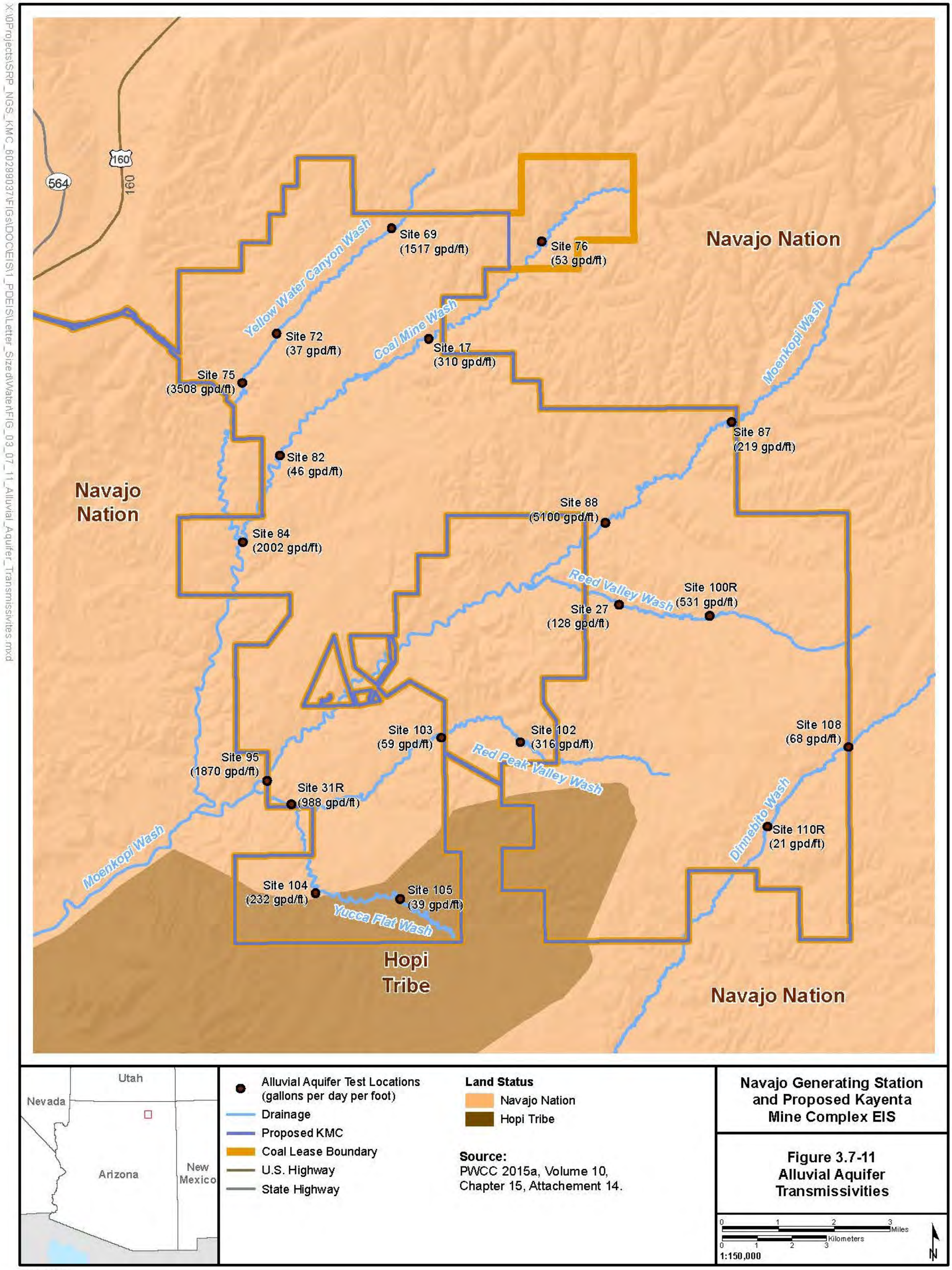


Figure 3.7-11
Alluvial Aquifer Transmissivities

Although surface water quality standard for livestock watering do not apply to groundwater in the alluvium or any other aquifer, sampling results have been compared to surface water standards simply as a source for comparison. Based on this, no exceedances of livestock watering standards established for surface water occur in recent alluvial groundwater data. See **Table 3.7-11** for a general summary and **Appendix WR-4**, **Tables WR-4.1** through **WR-4.7** for more detail. Along Moenkopi Wash upstream of the mine areas, recent (2010-2014) background TDS concentrations ranged from 2,400 to 9,900 mg/L, and sulfate values ranged from 1,470 to 6,300 mg/L. Upstream of mining along Dinnebito Wash, recent TDS concentrations in alluvial wells ranged from 2,550 to 3,160 mg/L, and sulfate values ranged from 4,380 to 4,990 mg/L. These fairly high values reflect undisturbed conditions for the higher topography and geologic setting of Black Mesa. Broadly similar elevated TDS concentrations are reflected in recent data downstream along Yellow Water Canyon, Reed Valley Wash, and Dinnebito Wash through the mine area. For sulfate, median values along Yellow Water Canyon Wash, Moenkopi Wash, Red Peak Valley Wash and Dinnebito Wash range from about 2,000 to 2,500 mg/L. A broader sulfate range occurs along Coal Mine Wash and Reed Valley Wash, with median values of 3,400 and about 3,800 mg/L, respectively. In summary, water quality in the narrow alluvial deposits upstream of and through the coal leasehold reflects fairly high TDS and sulfate contents, but trace element concentrations are low or undetected.

Table 3.7-11 General Alluvial Groundwater Quality Characteristics

Alluvial Drainage at the Kayenta Mine	General Groundwater Quality Type
Yellow Water Canyon Wash	Mixed sulfate
Coal Mine Wash	Mixed sulfate
Moenkopi Wash	Variable: mixed bicarbonate to mixed sulfate
Reed Valley Wash	Mixed sulfate
Red Peak – Yucca Flat – Sagebrush washes	Variable: calcium bicarbonate to mixed sulfate
Dinnebito Wash	Mixed sulfate or calcium sulfate

Source of monitoring data: PWCC 2012 et seq..

3.7.3.3.2 Springs and Seeps at the Proposed KMC

3.7.3.3.2.1 Spring Flow Quantities

Flows from monitored springs are summarized in **Appendix WR-3, Table WR-3.1**, and their locations are depicted on **Figure WR-3.1**. Long-term monitoring, which includes recent data, indicates typical flows of less than 1 gpm at most monitored spring locations. Monitoring data indicate that flows from most springs cease for extended periods. Larger flows and durations occur at Site Native Spring 561 along lower Red Peak Valley Wash, at Native Spring 563 nearby, and at Site Native Spring 92 on the northeast smaller tributary to Moenkopi Wash. These are supported by seepage from upstream ponds. Seasonal flows from springs often peak from late February through early April, and sometimes reach another peak in September or October. Maximum flows occasionally occur in the winter (November through January). Extended no-flow periods occur, particularly from late spring to late summer or early fall.

3.7.3.3.2.2 Spring Flow Quality

Water quality from recent (2010 through 2014) spring monitoring is summarized in **Appendix WR-3**, **Tables WR-3.2** through **WR-3.5**. Long-term data are summarized in **Appendix WR-3, Tables WR-3.6** through **WR-3.12**. Water quality from almost all monitored springs have elevated levels of sulfate and TDS, including those sites (such as Native Spring 111 or Native Spring 140) that have not been affected by mining activities. For example, recent sulfate values at Native Spring 111 are approximately 4,000 mg/L, and TDS concentrations there are over 6,000 mg/L. At Native Spring 140, typical long-term (since 1981) sulfate and TDS concentrations are approximately 3,000 mg/L and over 4,500 mg/L, respectively.

One exception to these generally elevated concentrations is Native Spring 91, located along Coal Mine Wash adjacent to the N2 mine area. TDS concentrations in samples from Native Spring 91 range from about 1,360 to 1,430 mg/L, with sulfate concentrations of about 680 to 800 mg/L. These values are relatively low concentrations for monitored springs, and more typical of Wepo Formation wells near mining.

3.7.3.3.2.3 Seeps

Seeps also occur in scattered locations in the coal lease areas and are monitored through the seep management program. This is conducted by PWCC in response to USEPA water quality requirements through NPDES permitting. These seeps are associated with sedimentation structures upstream. Water quality of the seeps is influenced by the geologic strata in the vicinity of the pond, and by the earthen materials used to form the embankment. Seep drainage quickly dissipates into the alluvium downstream of the ponds, and does not influence more distant resources.

Documentation in associated reports indicates that USEPA determined that the following designated uses and associated criteria from the applicable Hopi Tribe and/or Navajo Nation surface water quality standards for evaluating seep water quality (PWCC 2012 et seq.):

- Agricultural Livestock (Livestock Watering);
- Partial Body Contact (Secondary Human Contact); and
- Ephemeral Warm Water Aquatic (Aquatic and Wildlife Habitat).

Seeps generally flow at smaller rates than springs and typically form as wet spots lacking a free-water surface. Their occurrence at the Kayenta Mine is managed by inspection, pond dewatering and water transfers between ponds, fencing to restrict livestock access, pond removal, and other actions. A formal seep management planning and reporting program is active at the Kayenta Mine, as conducted by PWCC and coordinated with, and reported to USEPA and OSMRE. Between 10 and 15 seeps have been monitored each year since 1999 (Tinger 2015). Historically, 21 sites have been monitored in total, with seeps occurring at 20 sites. USEPA has established a set of “risk levels” and defined them as described below (Tinger 2015):

- Level 1: “Generally contains very low flows, few instances of observed seeps. If seep observed, seep meets water quality standards or had one sample slightly above water quality standards.”
- Level 2: “Generally contains medium flows, but seeps detected at higher frequencies. Multiple samples may be above water quality standards, but samples above water quality standards are only slightly above water quality standards. No samples significantly above water quality standards. No bioaccumulative toxic pollutant above water quality standards.”
- Level 3: “May be one or a combination of high flows, high occurrences of seeps, multiple samples above water quality standards, or any sample significantly above water quality standards. Any sample of bioaccumulative toxic pollutant above water quality standards is a Level 3 risk.”

Based on these USEPA-defined categories and PWCC monitoring, eight seep locations at the Kayenta Mine have been categorized during the program as Level 1, six as Level 2, and five as Level 3. Water quality standard are met at 2 locations, and are not met at 18 (Tinger 2015). Sulfate, aluminum, and TDS are the constituents typically exceeding applicable water quality standard. This is generally similar to conditions at springs described above.

3.7.3.3.3 Surface Water Features and Management at the Proposed KMC

The coal leasehold and surrounding area are described in Chapter 1.0 and depicted on **Figure 1-5**. Surface water resources on Black Mesa are dominated by sandy ephemeral washes, widely scattered springs, and constructed ponds. Stream segments are intermittent or perennial in some isolated locations due to contributions from springs and shallow aquifers. Springs are scattered throughout Black Mesa, particularly where erosion has cut cliffs or canyons across aquifer zones. In and near the coal leasehold (and elsewhere at the higher mesa elevations), these springs are mainly supplied by the Wepo or Toreva formations. They are geologically separated from those with D-Aquifer or N-Aquifer sources. Spring inventories have been conducted on the mesa and the N-Aquifer study area by the USGS and others. Recent spring inventories oriented to N-Aquifer features were conducted by the USGS expressly for the EIS. Further detail on this work is presented in **Appendix WR-10** (Leake et al. 2016). Major springs and many smaller ones have been located in relation to several aquifer zones as part of EIS data collection. These are discussed in later text sections and corresponding appendices. A number of siltation ponds and impoundments at the Kayenta Mine are incidentally used for stock watering.

3.7.3.3.3.1 Streamflow Quantity

As previously mentioned, major drainages on the mesa include Moenkopi Wash, Dinnebito Wash, Oraibi Wash, Wepo Wash, Polocca Wash, and far to the east, Jeddito Wash (**Figure 3.7-3**). Most of the mine leasehold area is drained by headwater tributaries to Moenkopi Wash. These include Coal Mine Wash, Yellow Water Canyon Wash, Yazzie Wash, Reed Valley Wash, Red Peak Valley Wash, and Sagebrush/Yucca Flat Wash. Dinnebito Wash and its tributary, Resting Cattle Wash, drain the southeastern part of the leasehold (**Figure 3.7-3**). The main channels generally parallel each other to the south and west, following the overall slope and geologic structure of Black Mesa. Major drainages and their tributaries cut canyons into bedrock as they drain to the Little Colorado River.

Measurements at 14 original stream gages established by PWCC indicate quick response to rainfall, often showing hydrographs with two or more “peaks.” This is due to the nature of storm tracks across the highly dissected bedrock-controlled landscape. As a heavy rainfall cell moves across the tributary watersheds and the main branch of a wash, the times when flows reach a downstream measurement point vary according to the rainfall track and time-of-travel through side-channels and channels. For intense storms, the response times to rainfall are short, creating discharges typified by “flashy” rises and rapid declines (PWCC 2012 et seq.). As described in the PAP, multi-peaked hydrographs occur from one-third to two-thirds of the time based on PWCC stream monitoring data, with even greater occurrence in the fall. Similar conditions are shown in USGS monitoring. The original 14 gages were located to provide upstream-of-mining and downstream-of-mining streamflow and water quality information, and to characterize streamflow and runoff from a variety of drainage areas, vegetation, slopes and channel densities, and other watershed variables. Strong correlations between precipitation types (snowmelt, convective, or frontal events) and their resulting runoff hydrographs were able to be determined. In conformance with regulations, the number of stream monitoring locations was subsequently reduced when sufficient and reliable flow and water quality characterizations had been made (OSMRE 2011b).

Recent PWCC data (2009–2013) in **Table 3.7-12** indicate the following wide ranges of peak flows at ongoing monitoring stations on major washes in the lease areas. These locations are depicted in **Appendix WR-1, Figure WR-1.1**. The ranges in flows chiefly result from variations in rainfall and snowmelt, as well as impoundment retention. Additional discussion of surface flows is in **Appendix WR-1**, including USGS monitoring of Coal Mine Wash (**Table WR-1.5**).

Table 3.7-12 Peak Flows at Current PWCC Streamflow Gages

PWCC Streamflow Gage	General Location	Range in Peak Discharges (cfs)	Range in Flow Durations (hours)	Annual Site Runoff (acre-feet)
SW25	Coal Mine Wash near mouth	0.1 to 1,509	1.7 to 67	19.3 to 1,131
SW26	Moenkopi Wash, just above Red Peak Valley Wash	1 to 5,508	0.23 to 76.5	60.3 to 4,173
SW34 [1]	Dinnebito Wash at south edge of lease area	2.24 to 1,110	4.24 to 45	166 to 674
SW155	Red Peak Valley Wash near mouth, at Moenkopi Wash	0.05 to 8,000	1.3 to 30.2	12.6 to 735.9

[1] Based on records for 2011 through 2013.

cfs = cubic feet per second.

Source: PWCC Annual Reports 2009-2013.

3.7.3.3.3.2 Streamflow Quality

Water quality sampling and data interpretations for the coal lease areas have been carried out by PWCC since beginning in the early 1980s. Recent stream water quality data were obtained from PWCC and are summarized in **Tables WR-1.6** through **WR-1.20** in **Appendix WR-1**. Streamflow monitoring locations are depicted in **Appendix WR-1, Figure WR-1.1**. These data represent current stream water quality characteristics monitored within the lease areas, as well as stream water quality leaving the lease areas. Major channels, including Yellow Water Canyon Wash, Coal Mine Wash, Moenkopi Wash, Red Peak Valley Wash, and Dinnebito Wash are represented. Longer-term water quality characteristics from other PWCC stream monitoring sites are discussed below as part of the cumulative (in time) affected environment description.

In general, stream water quality data from the near-term period 2010 through 2014 (5 years) indicate that streamflow and surface water runoff samples collected at stream monitoring sites established within or just downstream of the coal lease areas have mixed major cation chemistry (calcium, magnesium, and sodium), with sulfate as the dominant anion. TDS concentrations generally range from about 2,000 mg/L to about 5,000 mg/L, but are lower in some cases. The greater concentrations occur during baseflow periods, when streamflows consist of low flows from groundwater contributions. TDS concentrations generally decline during rainfall periods, when larger flow rates and overland runoff feature measurably lower dissolved fractions compared to groundwater baseflow. This can be seen by comparing the median TDS concentration for mixed flows (2,210 mg/L) in **Appendix WR-1, Table WR-1.8** to the median value (5,530 mg/L) for baseflows at the same location in **Appendix WR-1, Table WR-1.9**. The groundwater typically carries greater dissolved concentrations of common constituents (calcium, magnesium, sodium, chloride, sulfate, bicarbonate, and others).

Total Suspended Solids (TSS) concentrations vary widely between low flows to higher, runoff-generated flows. Very high suspended solids values result from the intense storms common to the leasehold and the overall study region (for example, up to 131,000 mg/L in **Appendix WR-1, Table WR-1.8**). Historical measurements (prior to 2010) of TSS in larger runoff events have commonly yielded values in excess of 200,000 mg/L. This constituent reflects the sediment transport conditions common to the study region. Large runoff events (flash floods) typically transport sediment comprised of fine sands, silts and clays along with some organic materials. These fine particles have an affinity for binding trace elements to their surface micro-structure. Samples collected for trace element analysis using the total or total recoverable analytical methods are not filtered before delivery to the analytical laboratory. This contrasts with the filtered samples used for dissolved trace element analysis. Consequently, trace element concentrations in high runoff with very high TSS loads that are analyzed using the total or total recoverable method can be much higher compared to the dissolved concentrations. For example, this effect can be seen by comparing total to dissolved concentrations for arsenic, copper, and lead in **Appendix WR-1, Table WR-1.8**, which represents both sediment-transporting runoff and lower, baseflow conditions. The median total arsenic concentration is 215 μg/L (0.215 mg/L) whereas the median dissolved arsenic concentration is 0.90 μg/L (0.0009 mg/L). The median total copper concentration is 1,285 μg/L (1.28 mg/L) whereas the median dissolved copper concentration is 4.10 μg/L (0.004 mg/L). The median total lead concentration is 895 μg/L (0.895 mg/L) whereas the median dissolved concentration is 0.30 μg/L (0.0003 mg/L). In contrast, **Appendix WR-1, Table WR-1.9**, which represents only low-TSS baseflow at the same site, indicates that neither total nor dissolved concentrations were detected for these trace elements. Very low TSS concentrations are represented in that table.

Water quality standards used for discussion and assessments are based on the more typical uses of surface waters in the study area, on public scoping concerns, and on agency guidance and past documentation from OSMRE (OSMRE 2011b). Related standards are presented in **Appendix WR-1, Tables WR-1.1** through **WR-1.4,** for both the Navajo Nation and the Hopi Tribe. Exceedances of water quality standards do occur for some constituents at some locations, most notably during storm runoff when total concentrations of trace elements are elevated by much greater TSS concentrations. No applicable standards are exceeded in baseflows on middle reaches of Yellow Water Canyon, Coal Mine Wash (Site SW80R), or Moenkopi Wash (Site SW2a) near active mining or reclaimed lands in the middle of the coal lease areas.

In recent (2010 through 2014) data elsewhere, sulfate, TDS, TSS, and total aluminum and iron are the constituents more likely to exceed the most protective water quality criteria or recommended values. Sulfate and TDS exceedances occur in both baseflows and runoff samples, whereas total aluminum and iron exceedances are typical only during runoff. During high runoff events, other constituents such as lead, mercury, selenium, and vanadium commonly have concentrations above the most protective standards as well. For these other constituents, exceedances of the most protective water quality standards generally occur in about 33 to 67 percent of samples from runoff events. Selenium exceedances can be more frequent during high runoff events, for the same elevated TSS reasons described above. These conditions are common to the erosive landscapes typical of watersheds with Cretaceous or younger shales or clays in the region.

Opportunistic livestock watering is perhaps the dominant use of surface water in the coal lease areas. Related standard exceedances are somewhat less frequent for the livestock use, but still occur with arsenic, chromium, copper, lead, and vanadium during large runoff events. Total selenium concentrations that exceed the livestock criterion (50 μg/L) are rare; they only occur in about 17 percent of the runoff samples at Site CG34 on Dinnebito Wash. As mentioned above, of the total trace element concentrations are amplified during runoff because of their chemical association with sediment or organic particulates transported in runoff. These materials are retained in impoundments and siltation ponds downstream of disturbed areas. Large undisturbed areas without such controls still remain along major drainages outside of disturbed lands. It is likely that runoff from these areas is affected by particulates from overland flow or channel re-suspension, and reflect corresponding trace element characteristics.

Based on long-term stream monitoring (**Appendix WR-1, Tables WR-1.17, WR-1.18, WR-1.19,** and **WR-1.20**), water quality results indicate that downstream conditions on the leasehold generally reflect the background water quality of flows monitored upstream of mining activities. On Moenkopi Wash, the upstream dissolved arsenic median concentration is 2.0 μg/L (0.002 mg/L), and downstream it is 1.0 μg/L (0.001 mg/L). The median total selenium concentration is 6.5 μg/L (0.006 mg/L) upstream, and 3.0 μg/L (0.003 mg/L) downstream. The background median TDS concentration is 390 mg/L, and the downstream value is 690 mg/l. The background median sulfate concentration is 150 mg/L, and the median downstream concentration is 383 mg/L. On Dinnebito Wash, the upstream background and the downstream median dissolved arsenic concentrations are similar, at 2.0 and 1.5 μg/L (0.002 and 0.0015 mg/L), respectively. The background median total selenium concentration is 4.5 μg/L (0.0045 mg/L), compared to a downstream median of 3.5 μg/L (0.0035 mg/L). The background median TDS value is 1,239 mg/L upstream, compared to a downstream value of 927 mg/L. The background median sulfate concentration on Dinnebito Wash is 786 mg/L upstream, compared to a downstream median of about 590 mg/L. These results indicate that, while there is some stream water quality variation between drainages and across the leasehold, the downstream conditions generally reflect naturally occurring conditions upstream.

3.7.3.3.3.3 Pond Quantities

Impoundments and sediment ponds at the Kayenta Mine are described in Chapter 1.0. The number of ponds changes as mining and reclamation proceed. In summary, by the year 2019 there will be 50 permanent impoundments, 115 temporary impoundments, and 101 reclaimed impoundments. Over the Life-of-Mine, there would be 51 permanent impoundments and 142 temporary impoundments. During reclamation over the Life-of-Mine, 241 impoundments would be reclaimed. All of these features have been or would be designed, built, and operated in accordance with federal regulations and current permit provisions. Design and construction are supervised by registered professional engineers in accordance with standard engineering practice and OSMRE-approved technical approaches.

For recent conditions, approximately half of the sediment ponds in the mine lease areas are fenced; the remainder are open to livestock. In the future, a portion of the ponds would remain after reclamation on the mine lease areas as permanent features for livestock watering (PWCC 2012 et seq.). PWCC has constructed and operated eleven impoundments on the proposed KMC that meet the Mine Safety and Health Administration criteria for dam design, construction, and inspection. These structures also have been designed, built, and maintained in accordance with regulations. Individual storage capacities of the Mine Safety and Health Administration impoundments on the Kayenta Mine operations area range from approximately 20 to 560 acre-feet.

3.7.3.3.3.4 Pond Water Quality

In general, about half of the existing ponds at the Kayenta Mine are currently open to livestock and wildlife; the remainder are fenced off from livestock. Recent repeated sampling on about 20 ponds across the Kayenta Mine has provided water quality data for these features and generally the water quality is adequate for use by wildlife and livestock consumption (**Appendix WR-2**, **Figure WR-2.1**). The data are summarized in **Appendix WR-2, Tables WR-2.1** through **WR-2.3**.

3.7.3.4 Transmission Systems and Communication Sites

The alignments of the transmission system associated with NGS are depicted in **Figure 1-14**. Principal stream crossings along the transmission system are listed in **Appendix WR-8, Table WR-8.22**.-Most of these channels are dry, sandy washes that only flow in response to precipitation. A few streams (or stream reaches) are intermittent or perennial. These have longer seasonal or year-around flows supported by groundwater contributions or by outflows from nearby reservoirs or conveyances. Numerous smaller ephemeral and intermittent washes not listed in **Appendix WR-8** also are crossed by the transmission line alignments. The following streams have perennial flow segments in or near the transmission line ROWs:

- WTS – Colorado River, Paria River, Muddy River, Virgin River, Las Vegas Wash, and Meadow Valley Wash.
- STS – Agua Fria River, Big Bug Creek, and Verde River.

Some of these crossings are located in deep canyons that are spanned by transmission lines high overhead. Others are simply shallow washes where transmission structures have been placed on nearby uplands. Habitats and riparian conditions along streams and washes are described in their respective resource sections of the EIS.

3.7.4 Environmental Consequences

3.7.4.1 Issues, Assumptions, and Impact Methodology

The impact assessments for water resources address issues or concerns received as project input during public and agency scoping during 2014 and in subsequent meetings. Oral and written comments were received from public participants, cooperating agencies, and tribal interactions. The water resources assessment addresses potential impacts from a Western scientific viewpoint. The evaluations are based on collection and review of agency and private data, including previous National Environmental Policy Act (NEPA) documents. Groundwater levels, channel flow data, water quality information and spring surveys were among the information sources used. Resource considerations from public scoping meetings and agency interactions guided the process.

Potential impacts to surface water and shallow groundwater (the alluvial and Wepo aquifers) were assessed from existing monitoring data collected over time, established designated uses per water quality standards, published agency reports, and permit documents. These materials are cited in the discussions. Assessments for the deeper groundwater zones (the D-Aquifer and N-Aquifer) used a combination of existing data from agencies, SRP, and PWCC, as well as new inventories and numerical computer modeling.

Since the effects of groundwater drawdown in the N-Aquifer are a major concern identified during public scoping, a numerical groundwater model was used to predict future effects. The prediction period extends to the Year 2110; hence the application of a predictive computer model. The USGS was tasked with independently reviewing and discussing available groundwater models with the EIS team, and the agency provided input to the modeling effort. A separate USGS document related to that effort has been prepared (Leake et. al 2016). As part of this EIS, summaries of groundwater modeling and the USGS work are presented in **Appendices WR-9** and **WR-10**.

The effects of different actions were estimated by the model in a manner which takes into account historical effects and other pumping scenarios. For example, the effects of Peabody's pumping through the end of 2019 were calculated by running two different simulations. One of the simulations included all (community and Peabody production) historical and predicted pumping through 2019, while the other eliminated the Peabody wells. The differences between the model's output for these two simulations provide the effects of Peabody's pumping. Another comparison was performed to evaluate the effects of the Proposed Action. The two simulations used for this comparison were (1) a simulation with historical pumping, projected tribal pumping through 2110, and project-related PWCC pumping through 2055, and (2) a simulation with historical pumping, projected Tribal pumping through 2110, and No Action pumping by PWCC through 2033 (because of pumping associated with reclamation activities). The differences in this case provide the effects of pumping associated with the Proposed Action. Calculating the effects in this manner is required because the groundwater system is currently recovering from the effects of greater pumping (through 2005) by PWCC.

In addition, an inventory of regional springs that discharge from the N-Aquifer was conducted by the USGS for the EIS (Leake et al. 2016). This involved new inventory work, as well as subsequent interactions with the EIS team to cross reference the new results with earlier inventories in the region. A summary of spring inventory work for the EIS is presented in **Appendix WR-10.**

3.7.4.1.1 Navajo Generating Station

For the NGS, scoping concerns or issues addressed by the water resources assessment include:

- Additional disposal of dry coal combustion products in the existing or expanded ash disposal area could adversely affect surface water or groundwater quantity or quality.
- Spills or leaks from water use at NGS, existing or new fluid storage, or evaporation ponds could adversely impact surface water or groundwater resources.
- Water withdrawals from Lake Powell for NGS operations could affect the water level and surface area of the reservoir.
- Airborne deposition of trace elements and/or acid-forming constituents could change water quality to conditions other than typical regional background values, or to exceedances of relevant water quality standards.

3.7.4.1.2 Proposed Kayenta Mine Complex

For the proposed KMC, scoping concerns or issues addressed by the water resources assessment include:

- Groundwater drawdown from mine-related pumping at the proposed KMC could reduce water levels in N-Aquifer public water supply wells.
- Proposed pumping could reduce N-Aquifer water quality by increasing leakage from the D-Aquifer across the Carmel Formation.
- Flow reductions at springs/seeps could occur as a result of proposed mine-related pumping at the proposed KMC (D- and N-Aquifers).
- Regional flow reductions along streams supported by the N-Aquifer may result from proposed mine-related groundwater pumping.
- Pumping withdrawals from the N-Aquifer could be reduced by developing a D-Aquifer supply for mining and reclamation activities. This could improve the long-term sustainability of the N-Aquifer.
- Groundwater drawdown in the Wepo Formation could occur from mine pit development and reclamation. This could reduce supplies to formation wells or contributions to connected springs and alluvium.
- Water quality in the Wepo Formation could be reduced by mining and reclamation activities with additional effects on hydrologically connected seeps, springs, channel baseflows, and alluvial deposits.
- The quantity of water in alluvial deposits could be reduced by mining activities such as pit development, water management, and reclamation. This could affect existing uses such as livestock watering or riparian habitat.
- The quality of water in alluvial deposits could be reduced by mining activities. This could affect existing uses such as livestock watering or riparian habitat.
- Streamflows and related designated uses downstream along Moenkopi Wash or Dinnebito Wash could be reduced by water retained in additional ponds and impoundments at the proposed KMC.
- Surface water quality could be reduced by mining activities and discharges from the proposed KMC, and that could impact designated uses downstream along Moenkopi Wash or Dinnebito Wash.

- Ponds and impoundments at the proposed KMC might not be adequately built or maintained to control runoff and provide supplemental water supplies. Water quality in ponds and impoundments may not be suitable for existing designated uses.

3.7.4.1.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

For the transmission systems, scoping concerns or issues addressed by the water resources assessment include:

- Water quality in streams crossed by transmission lines could be reduced by maintenance activities in the transmission line ROWs.

3.7.4.2 Proposed Action

3.7.4.2.1 Navajo Generating Station

3.7.4.2.1.1 Ash Disposal Area

- Scoping Concern: Additional disposal of dry coal combustion products in the existing or expanded ash disposal area could adversely affect surface water or groundwater quantity or quality.

Impacts from On-site Disposal of CCRs, 3-Unit Operation	Impacts from On-site Disposal of CCRs, 2-Unit Operation
The existing disposal facility would continue to be used, but would be expanded when needed using appropriate design and construction methods in accordance with regulations and agency interactions. Roughly 80 acres of additional upland watershed area would be disturbed for additional dry ash disposal. Water monitoring and site inspections would continue. No impacts to water resources would occur at the facility.	The existing dry ash disposal area would provide sufficient storage through the Year 2044. Water monitoring and site inspections would continue. No observable impacts to water resources would occur at the facility.

Disposal of dry coal combustion residuals would occur at NGS under either Proposed Action options. As described in Chapter 1.0, remaining storage capacity at the existing ash landfill is adequate for the 2-Unit Operation through the Year 2044. Additional runoff and run-on control features and other practices to protect water resources would be implemented in accordance with agency requirements. Expansion of dry-ash storage capacity would be required at some time under the 3-Unit Operation. If an expansion is necessary, it would be constructed as a northward extension of the existing landfill area on similar terrain. Contouring and compaction, a protective terraced berm, and additional surface drainage controls on surrounding lands would be incorporated in any new facility construction.

Groundwater monitoring and site inspections are part of existing site management by SRP. These would continue with either Proposed Action options, in accordance with USEPA regulatory programs (Coal Combustion Residuals Rule) and the NGS-specific Groundwater Protection Plan. Water in the N-Aquifer is approximately 824 feet or more below the ground surface at Well DW-3 at the dry ash disposal area. The original layers of fly ash and bottom ash were placed as engineered fill and were compacted at optimum moisture with a sheep's foot vibrating compactor. Subsequent borings (and boring refusals) indicate that the original layers are the strength of lean concrete, and provide a barrier to the aquifer over 800 feet below (**Appendix 1B**). Further dry ash landfill construction information is presented in the

Groundwater Protection Plan of **Appendix 1B.** Additional subsurface moisture conditions have periodically been investigated by neutron logging at several boreholes, both at the plant and the dry ash disposal landfill. These efforts and respective well locations are detailed in Appendix 2 of Appendix C of **Appendix 1B**. Although dust suppression water is applied to the dry ash landfill, no saturated conditions occurred in Well N-72 logged to a depth of 440 feet bgs in 1997 (**Appendix 1B**). This borehole is located in the north central part of the dry ash landfill (**Appendix 1B**). Outside the dry ash landfill, fracture flow (roughly 1 to 2 gpm) was noted in Well DW-3 at approximately 569 feet bgs in 1997 and again in 2015. That well has since been cased to prevent vertical conduit issues. Moisture conditions at depth in DW-3 have been relatively unchanged between 1997 and 2015 (**Appendix 1B**). Past monitoring of both neutron wells and water quality in deep wells found that the dry ash disposal area is not leaking or contributing to moisture in the Navajo sandstone below the site (**Appendix 1B**). Based on available information, no impacts to surface water or groundwater quantity or quality have occurred at the dry ash disposal facility under existing conditions. With continued operations and regulatory compliance, no impacts to groundwater resources would occur at the dry ash landfill under either Proposed Action option.

For the Proposed Action 3-Unit Operation, additional storage capacity would remove a comparatively small area from contributing to surface water runoff. Given the existing acreage and capacity (765 acres for 38 million cubic yards), additional storage for an estimated 3.7 million cubic yards would likely involve a dry, upland area of roughly 80 acres or less. This would not noticeably affect surface water yield from the arid area.

The current Groundwater Protection Plan, due to the staged implementation of the USEPA Coal Combustion Residuals Rule, is the current mechanism to ensure groundwater monitoring and site inspections are conducted for the ash landfill area. The inspection mechanism under the Coal Combustion Residuals Rule (Inspections: §257.84) is two-fold, with a seven-day Coal Combustion Residuals Landfill inspection that began no later than October 19, 2015, and an annual Coal Combustion Residuals Landfill inspection that commenced no later than January 18, 2016, per the rule. One outcome of these inspections was a recommendation to repair eroded areas of the existing landfill. SRP will conduct maintenance in compliance with requirements.

Additionally the USEPA Coal Combustion Residuals Rule requires the owner or operator of the Coal Combustion Residuals Landfill to be in compliance with the groundwater monitoring requirements (Groundwater Monitoring and Corrective Actions: §257.90-§257.98) no later than October 17, 2017. Coal Combustion Residuals compliance activities related to the Coal Combustion Residuals Landfill that must be implemented no later than October 17, 2017, include investigation of the hydrogeological setting, periodic inspections and maintenance activities, installation of a groundwater monitoring system, development of a groundwater sampling and analysis plan, conducting baseline monitoring to establish background levels, initiating a detection monitoring program and beginning to evaluate the groundwater monitoring data for statistically significant increases over background levels. Until October 17, 2017, the NGS Groundwater Protection Plan will continue the Coal Combustion Residuals Landfill groundwater monitoring and site inspections; after that date the Groundwater Protection Plan will be re-drafted to cover the NGS plant site, and the Coal Combustion Residuals rule will be utilized for the Coal Combustion Residuals Landfill components. The O&M Plan will be updated to include this transition for the Coal Combustion Residuals Landfill from the Groundwater Protection Plan program management to the Coal Combustion Residuals rule.

Closure and post-closure activities at the ash disposal landfill would be planned and implemented under the direction of a registered Professional Engineer according to accepted professional engineering practices, and in accordance with the Groundwater Protection Plan and Coal Combustion Residuals Rule. Closure and post-closure activities are described further in the Coal Combustion Residuals Ash Disposal Landfill Requirements and the NGS Groundwater Protection Plan (Appendices B and C, respectively, included as parts of **Appendix 1B**). Because of these measures, no impacts to water resources would occur at the facility under the 3-Unit Operation or 2-Unit Operation.

3.7.4.2.1.2 Water Use at NGS and Storage in Existing and New Ponds

- Scoping Concern: Spills or leaks from water use at the plant, or existing or new fluid storage or evaporation ponds, could adversely impact surface water or groundwater resources.

Impacts from Water Use at the plant, Existing or New Storage Ponds, 3-Unit Operation	Impacts from Plant Water Use, Existing or New Storage Ponds, 2-Unit Operation
No water resources impacts are anticipated from ongoing uses of water at NGS under proposed operations and maintenance. Activities conducted through the Groundwater Protection Plan (e.g., the Perched Water Dewatering Plan), facility inspections, and maintenance would continue to monitor water resources and appropriately implement mitigation. Impacts to water resources from any new ponds would be avoided by proposed engineered design and construction, monitoring, and maintenance. Ongoing implementation of the Perched Water Dewatering Plan would continue to avoid impacts from leakage at the plant site. Closure and post-closure practices would avoid impacts during those phases.	Potential impacts would be the same as those described for the 3-Unit Operation.

As described in Chapter 1.0, expansion of other process components, disposal areas, or containment features would occur at NGS with either the 3-Unit Operation or the 2-Unit Operation. Likely expansions would include the water treatment (evaporation) ponds. Existing fluid ponds would continue to be used, and new ponds may be constructed to facilitate the efficient operation of the zero discharge facility. Any new pond constructed in the near-term or future would be within the existing plant site and would meet the standards defined in the Groundwater Protection Plan. Any additional ponds would be constructed with liners and leak detection systems appropriate to their use and fluid contents.

The Perched Water Dewatering Work Plan (**Appendix 1B**) describes the extraction of perched water by existing NGS wells, and its discharge back to plant process streams for re-use. Discharge sampling and overall program reporting are part of the ongoing activities under this agency-approved plan. Because of the previous implementation and ongoing operation of this plan, no impacts to the N-Aquifer would occur from plant leakage at NGS. No impacts to surface water or groundwater resources (i.e., N-Aquifer) have been identified at NGS from the use of water at NGS, including the existing solution and evaporation ponds. No impacts are anticipated from continued uses of existing ponds or from additional ponds, because they would be built, inspected and maintained as described above (see **Appendix 1B** for more detail) during the life-of-project.

Closure and post-closure activities related to water resources are described further in the NGS Groundwater Protection Plan. For ponds, closure and post-closure activities for ponds would be planned and implemented according to accepted professional engineering practices in accordance with the Groundwater Protection Plan (**Appendix 1B**). Decommissioning practices and post-closure activities, including a comprehensive environmental site assessment and other practices, are further described in Chapter 1.0 and **Appendix 1B**. In summary, activities and practices related to water resources will include the following (**Appendix 1B**):

- Soil sampling (and remediation if necessary) will be carried out, and practices for site stabilization, capping, and controlling runoff/run-on and erosion will be implemented;

- The draining, testing, and disposal of fluids will follow applicable USEPA regulations. The final determination of closure actions would depend on test results;
- For covering process wastewater ponds and landfills, the general requirements, conceptual approaches, design and construction, maintenance, and duration of responsibility will be determined and implemented according to future engineering studies and recommendations developed in coordination with applicable regulatory programs;
- Post-closure monitoring would be determined through future engineering studies and recommendations by a Professional Engineer; these could include maintaining the existing the monitoring system and protocols as described in the Groundwater Protection Plan. Post-closure monitoring will require establishing an agreement with the Navajo Nation for access.
- Well closure/abandonment, and testing of existing or newly constructed pond liners followed by on-site burial or disposal, will be conducted according to future engineering studies and recommendations developed in coordination with applicable regulatory programs. Wells necessary for post-closure monitoring would be retained.

Based on the successful planning and implementation of these protocols and practices, no impacts to water resources during closure activities or the post-closure period would occur from either Proposed Action option.

3.7.4.2.1.3 Lake Powell

- Scoping Concern: Water withdrawals from Lake Powell for NGS operations could affect the water level and surface area of the reservoir.

Impacts from NGS Withdrawals, 3-Unit Operation	Impacts from NGS Withdrawals, 2-Unit Operation
Under full pool conditions, pumping of 29,000 acre-feet per year from Lake Powell would reduce the nominal reservoir water level by about 2 inches. The surface area would be reduced by about 132 acres. Under severe drought conditions, the nominal reservoir water level would decline by about 4.5 inches, and the surface area would be reduced by about 167 acres.	Under full pool conditions, pumping of 18,700 acre-feet per year from Lake Powell would reduce the nominal reservoir water level by about 1.4 inches. The surface area would be reduced by about 88 acres. Under severe drought conditions, the nominal reservoir water level would decline by about 3 inches, and the surface area would be reduced by about 112 acres.

Under the Proposed Action, withdrawals from Lake Powell would continue to occur as needed to supply NGS operations. For the 3-Unit Operation, approximately 29,000 acre-feet per year would be withdrawn from the lake using the deep intakes, pump station, and pipelines described in the Affected Environment sections and in Chapter 1.0.

An annual withdrawal of 29,000 acre-feet at NGS would represent approximately 0.11 percent of total reservoir water capacity at a pool elevation 3,700 feet, based on recent information (Reclamation 2007). At an elevation of 3,700 feet, Lake Powell has a surface area of approximately 160,784 acres

The lowest recorded pool elevation for Lake Powell occurred at 3,555.1 feet in early April 2005. At that elevation, an annual withdrawal of 29,000 acre-feet would represent about 0.28 percent of total reservoir water capacity. At an elevation of 3,555 feet, Lake Powell has a surface area of approximately 73,787 acres.

Under the Proposed Action, 2-Unit Operation, approximately 19,340 acre-feet would be withdrawn annually by NGS. An annual withdrawal of this amount would represent approximately 0.07 percent of reservoir storage at an elevation of 3,700 feet.

Because of the small incremental changes projected above, and the normal variations in Lake Powell pool elevations, wind and rain effects, and annual and seasonal inflows, there would be negligible impacts from NGS withdrawals under either Proposed Action options. No impacts would occur from the continued operation or maintenance of the existing water intake, pump station, or water supply pipelines.

- Scoping Concern: Airborne deposition of trace elements of concern (arsenic, mercury, selenium) and/or acid-forming constituents could change water quality within a 20-km radius of the station to conditions other than typical regional background values, or to exceedances of relevant water quality standards.

Impacts to Surface Water Quality from NGS Airborne Deposition, 3-Unit Operation	Impacts to Surface Water Quality from NGS Airborne Deposition, 2-Unit Operation
Very low rates of arsenic, mercury, or selenium deposition from NGS are predicted within the 20-km study area. Negligible impacts to water quality from these trace elements would result from the 3-Unit Operation. Negligible impacts from NGS acid deposition factors would occur.	Water quality impacts would be similar to, but less than, the negligible impacts described for the 3-Unit Operation.

Three trace elements were defined during the ERA work as being of potential concern: arsenic, mercury, and selenium. These constituents would be deposited on surface waterbodies by stack emissions from the NGS. The potential deposition concentrations and rates were determined by air quality modeling as described in Section 3.1. Predicted water concentrations due to deposition for the three trace elements on surface water are depicted on bar charts in the ERA appendix (**Appendix 3RA**). For arsenic, predicted water deposition concentrations are generally similar for both total and dissolved forms, approximately 0.0000013 mg/L (approximately 0.0013 µg/L). This is a negligible increase in water concentration due to deposition in comparison to existing background concentrations in Lake Powell and in the rivers regionally (see **Table 3.7-7** and **Appendix WR-8** information for Lake Powell, Colorado River, San Juan River). For total and dissolved mercury, predicted water deposition concentrations varied between 0.000000055 mg/L to 0.0000000032 mg/L (0.000055 to 0.0000032 µg/L) for the two Proposed Action options. Again, these are negligible compared to background values, and would not be detected by most laboratory water analyses. For selenium, predicted total and dissolved water deposition concentrations are approximately 0.00001 mg/L (0.01 µg/L) for the 3-Unit Operation, and about 0.000007 mg/L (0.007 µg/L) for the 2-Unit Operation (**Appendix 3RA**).

For the constituents of interest (arsenic, mercury, and selenium) the aquatic use chronic standards are as follows (Arizona Department of Environmental Quality 2016; NNEPA 2008; UDEQ-DWR 2016):

- Arsenic, dissolved, micrograms per liter: 150 (NNEPA); 150 (Utah); 150 (Arizona)
- Mercury, dissolved, micrograms per liter: 0.001 (NNEPA); 0.012 (Utah); 0.01 (Arizona)
- Selenium, dissolved (D) or total (T): micrograms per liter: 2.0 D (NNEPA); 4.6 D (Utah); 2.0 T (Arizona)

Arsenic and mercury constituent concentrations are within applicable chronic aquatic and wildlife standards for the Navajo Nation, State of Utah, and State of Arizona. As listed in **Table 3.7-7**, average background dissolved arsenic levels in Lake Powell and the Colorado River downstream (in the 20-km study area) range from 1.4 to 1.7 µg/L. With predicted deposition, arsenic concentrations would remain within water quality standards. Average background dissolved mercury concentrations range from 0.0004 to 0.0007 µg/L in Lake Powell and the Colorado River downstream (in the 20-km study area), as listed in **Table 3.7-7**. With predicted deposition, mercury concentrations would remain within water quality standards.

At most locations existing selenium concentrations are within standards, but in some cases are already at or above the standards for Arizona and NNEPA. Dissolved selenium concentrations in lower Lake Powell already numerically approach or exceed these standards (**Tables 3.7-7** and **Appendix WR-8, Table WR-8.13**). Background average selenium values in Lake Powell and the Colorado River downstream (in the 20-km study area) range from 1.5 to 2.2 μg/L. With predicted deposition, selenium concentrations would still closely reflect these existing conditions. Arizona water quality standards note that exceedances due to natural background conditions are not violations (Arizona Department of Environmental Quality 2016). Predicted water concentrations due to deposition of selenium, arsenic, and mercury would be negligible in comparison to existing concentrations. With additional inflows, outflows, and wave action on the reservoir, water quality impacts from predicted deposition of these constituents would be negligible.

Acid deposition was previously discussed in the Air Quality assessment, Section 3.1. The deposition rates were evaluated at 59 separate lakes and streams in Arizona, Colorado, and Utah. Cumulative sources would create major impacts at one waterbody (Section 3.1). The Anasazi Pond near Spillway, Utah was predicted to undergo 0.45 kg/hectare-year for sulfur deposition and 2.17 kg/hectare-year for nitrogen deposition. This is a major cumulative impact at this one location, but the NGS contribution is considered negligible. The NGS contribution at this receptor was approximately 2 to 3 percent of the total cumulative deposition. Because of this, acid-forming deposition impacts to surface water quality from NGS are considered negligible. Additional discussion of this issue is presented in Section 3.1.

3.7.4.2.2 Proposed Kayenta Mine Complex

3.7.4.2.2.1 N-Aquifer Water Levels, Water Quality, and Uses

- Scoping Concern: Groundwater drawdown from mine-related pumping at the proposed KMC could reduce water levels in N-Aquifer public water supply wells.

Impacts of Mine-Related Pumping on N-Aquifer Wells, 3-Unit Operation	Impacts of Mine-Related Pumping on N-Aquifer Wells, 2-Unit Operation
In and near the coal leasehold, mine-related pumping effects are predicted to create maximum N-Aquifer drawdowns of 50 to 100 feet or more. Farther from the mine pumping wells, predicted N-Aquifer drawdowns would be less. Maximum drawdowns of approximately 35 feet would occur at Forest Lake, and about 16 feet would occur at Pinon. Maximum drawdowns of approximately 14 feet would occur at Kayenta, with about 5.5 feet at Keams Canyon, and about 2.5 feet at Kykotsmovi and Rough Rock. In terms of groundwater uses, such mine-related drawdowns would create none to negligible impacts to N-Aquifer public water supply wells. Project-related impacts to pumping lift heights would be none to negligible since the predicted range in percent increased lift would vary from 0 to 3.7 percent. Maximum predicted N-Aquifer drawdowns would occur in different years at different locations.	Potential impacts would be the same as those described for the 3-Unit Operation.

The impact of pumping at the proposed KMC on water levels in the N-Aquifer has been assessed by estimating the change in water level (drawdown) in wells within the area of impact due to pumping. **Table 3.7-13** lists planned annual pumping from PWCC's NAV production wells during the Proposed Action. For purposes of the EIS, it is assumed that mine-related water demand for potable supply, fire suppression, and dust suppression (e.g., on haul roads, access roads, and facilities such as shops and storage areas) would be the same under the 2-Unit Operation as under the 3-Unit Operation. This assumption is based on the locations of proposed active coal resource zones, maintenance of related road and conveyor networks, and the continued need for similar water uses at the proposed KMC.

Table 3.7-13 Anticipated N-Aquifer Withdrawals for the Proposed KMC Operations

Years	Annual Withdrawals (acre-feet)
2020 - 2044	1,200
2045 - 2047	500
2048 - 2057	100

The estimate of future water level change is supported by a revised numerical model of Black Mesa prepared for PWCC by Tetra Tech, Inc. (Tetra Tech 2014). The PWCC groundwater flow model is a three-dimensional numerical model of the Black Mesa area. It is comprised of seven layers representing the D-Aquifer (Dakota, Morrison, Entrada/Cow Springs Member of the Entrada Sandstone), the Carmel Formation which serves as a confining bed for the underlying N-Aquifer (Navajo, Kayenta, and Wingate formations). The current model has been reviewed by the USGS and determined to be suitable for use in predicting water level change in N-Aquifer wells within the model domain (Leake et al. 2016). Details of the model, model files, and the USGS review are presented in **Appendices WR-9** and **WR-10**.

Numerical groundwater flow models are acknowledged to be "non-unique", meaning that more than one set of boundary conditions and aquifer parameters can produce essentially the same 'fit' to measured conditions. In the case of the current PWCC 3-D Groundwater Flow Model of the D- and N-Aquifers there are several aspects of model development that have constrained the selection of boundary conditions and model inputs. These are discussed in detail in **Appendix WR-9** and summarized below.

- There has been a rigorous annual pumping, water level, spring discharge, surface water flow and water quality data collection program by the USGS since 1971. These data have provided a reliable record of change in response to groundwater withdrawals.
- At least three other groundwater flow models of the same area and aquifers have been constructed. These models were independently developed and have provided a similar 'fit' to measured data with different model configurations.
- The current model was subjected to 'peer review' by the USGS. This review "found no problems with the PWCC model that would preclude its use by the NGS-KMC EIS team".

Modeling of the response to proposed future PWCC pumping on Black Mesa has benefited from the fact that past pumping has exceeded projected pumping by a factor of 4.5. Thus, the level of stress to be imposed on the aquifers by future PWCC pumping has been measured and the model calibrated to past PWCC induced changes in groundwater levels that are greater than those going forward. Furthermore the length of future PWCC pumping is limited to 45 years, minimizing the length of the projection period and the uncertainty associated with unknowable future conditions.

Community pumping is projected to 2110 (98 years), the total annual pumpage increases nearly six times and exceeds the maximum PWCC past pumping by a factor of four. Thus, uncertainty in model simulation of future water level conditions past the end of PWCC pumping (2057) is increased.

As discussed in **Appendix WR-9**, the accuracy of the simulation of past and future water levels varies throughout the model domain. In general the model produces good to very good 'fit' to measured water levels in the area of the leasehold and in major community pumping centers. The fit is poorer in areas distant from the leasehold and near the confined-unconfined N-Aquifer boundary.

Originally developed in 1999, the pumping data set for the model has been updated several times. In 2013-2014 the model was converted to the more recent USGS MODFLOW-NWT version, re-calibrated (using parameter estimation software) and updated with water level and pumping data through 2012. The model was calibrated by simulating measured water levels and stream and spring flow from 1956 through 2012. Pumping by PWCC at the Black Mesa-Kayenta leasehold began in the early 1970s. The model includes both PWCC pumping, municipal groundwater withdrawals by Navajo and Hopi communities and pumping from windmills from 1956 through 2012 (Tetra Tech 2014). In this report all references to ‘community’ pumping or withdrawal includes estimated withdrawal from windmills, even if not explicitly stated.

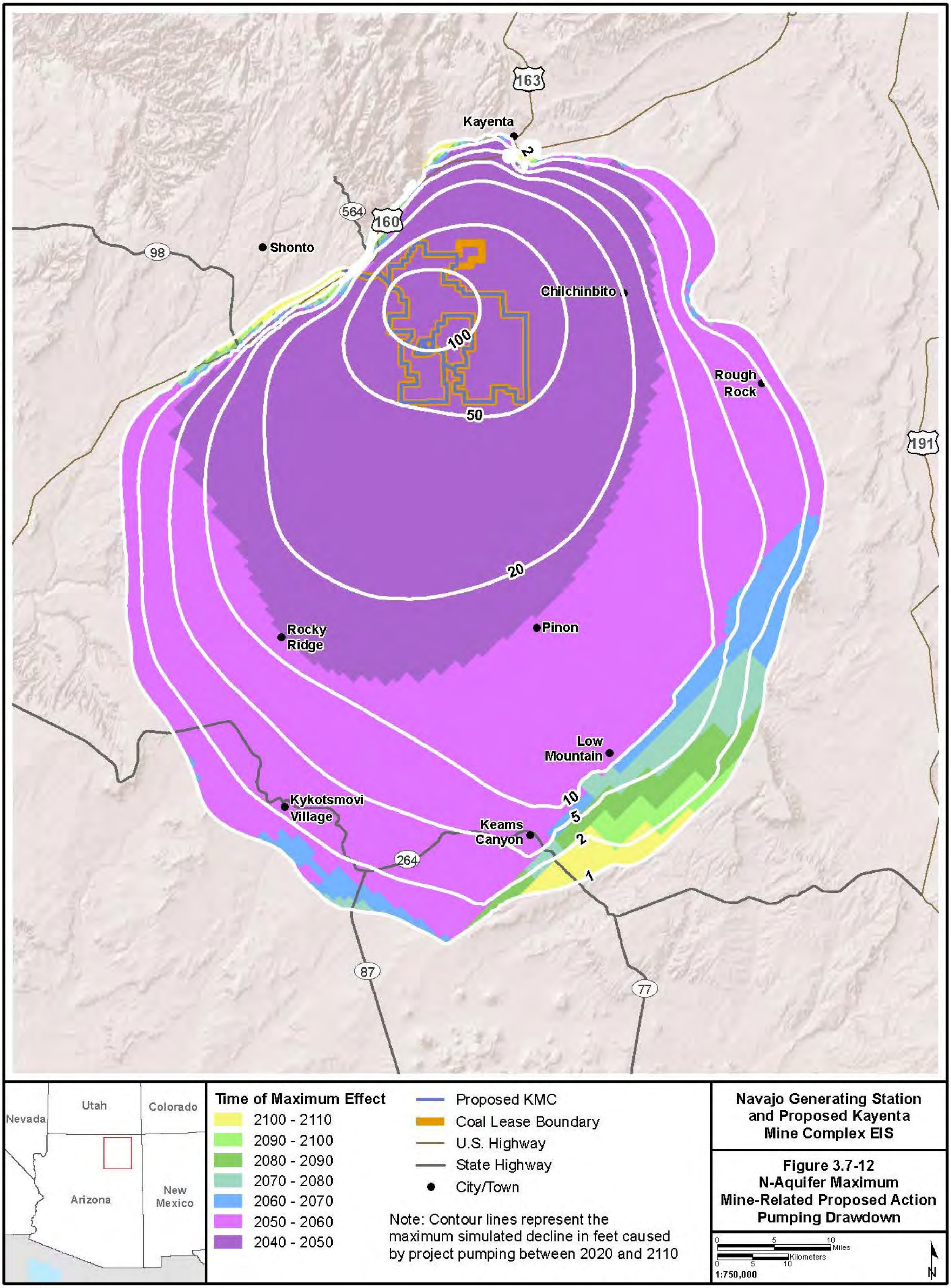
The model domain in relation to key geographic and project features is shown on **Appendix WR-8, Figures WR-8.6** and **WR-8.7**. As presented in Appendix B, Table B-5 of the 2011 Permit Renewal Environmental Assessment (OSMRE 2011a), total historical withdrawals from the N-Aquifer increased from about 70 to 8,000 acre-feet per year from 1965 to 2002, with the major increase due to industrial use by the wells for PWCC operations. In 1982 water use at the mine reached a maximum of 4,740 acre-feet per year. PWCC greatly reduced its N-Aquifer pumping at the end of 2005, when the coal slurry pipeline to the Mohave Power Plant ceased operations. Mine-related pumping has since been reduced to 1,584 acre-feet per year (as of 2014), and is projected to be reduced further under the Proposed Action as noted above.

Effects on water levels spread out unevenly over time, while the aquifer responds to pumping or to changes in pumping rates. There are time lags in these responses. Thus, the maximum impact of mine-related pumping occurs at different times in different locations. The PWCC model was run to estimate the time at which N-Aquifer water level declines of greater than 1 foot due to the Proposed Action pumping would begin to recover. This analysis predicted that maximum impacts due to mine-related pumping would be reached prior to 2111 (Tetra Tech 2014).

Predicted maximum mine-related drawdown due to the Proposed Action (3-Unit Operation) pumping is shown on **Figure 3.7-12**. Maximum drawdown at key community wells is given in **Table 3.7-14**, along with the year in which the maximum mine-related drawdown is predicted to occur. This table presents the maximum drawdown at each community; if a community has multiple wells, the value in the table is for the well with the greatest predicted drawdown. Smaller drawdowns occur in years other than those identified in **Table 3.7-14**, but they would be lesser effects. The table indicates the maximum predicted mine-related drawdown effect based on the model simulations. Note that the table presents the drawdown value for a single pumping scenario, assuming that N-Aquifer groundwater demand at the proposed KMC would be similar under either Proposed Action options.

As shown on **Figure 3.7-12**, the largest drawdown occurs nearest to the coal leasehold and PWCC NAV water supply wells, ranging from about 100 feet to about 50 feet. Drawdown also is greater in the confined area of the N-Aquifer due to the lower storage coefficient of the aquifer in this area. This is reflected in **Table 3.7-14**, where community wells within the confined zone and nearest the leasehold, such as Forest Lake and Chilchinbito, have the greatest maximum drawdown.

As identified in **Table 3.7-14**, the maximum simulated project-related drawdown would not occur everywhere in the N-Aquifer at the same time. For example, **Table 3.7-14** shows that Rocky Ridge and Low Mountain would have approximately the same simulated maximum drawdown (12.08 feet and 12.19 feet, respectively, but the years when this would occur are 2050 at Rocky Ridge and 2055 at Low Mountain. Similarly, the simulated maximum drawdown from Proposed Action pumping is 2.49 feet at both Rough Rock and Kykotsmovi, but this is estimated to occur in 2052 at Kykotsmovi and 2055 at Rough Rock. Thus, it should be clear that the drawdown contours depicted on **Figure 3.7-12** are spatial in nature, but that the timing of drawdown would vary between specific locations.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Kayenta
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160
98
Shonto
Chilchinbito
100
50
Rough Rock
191
20
Rocky Ridge
Pinon
Low Mountain
10
Kykotsmovi Village
5
Keams Canyon
2
264
1
87
77
Nevada
Utah
Colorado
Arizona
New Mexico
Time of Maximum Effect
2100 - 2110
2090 - 2100
2080 - 2090
2070 - 2080
2060 - 2070
2050 - 2060
2040 - 2050
Proposed KMC
Coal Lease Boundary
U.S. Highway
State Highway
City/Town
Note: Contour lines represent the maximum simulated decline in feet caused by project pumping between 2020 and 2110
Navajo Generating Station and Proposed Kayenta Mine Complex EIS
Figure 3.7-12
N-Aquifer Maximum Mine-Related Proposed Action Pumping Drawdown
Miles
Kilometers
1:750,000
7/20/2016

Table 3.7-14 Maximum Drawdown at Key Community Production Wells from Mine-Related Proposed Action Pumping

Community	Maximum Drawdown (feet) and Its Year of Occurrence [1]	
	3-Unit Operation	2-Unit Operation
Navajo		
Kayenta	13.73 feet, in 2097	Same
Shonto	0.01 feet, in 2040	Same
Dennehotso	0.01 feet, in 2063	Same
Chilchinbito	18.50 feet, in 2049	Same
Rough Rock	2.49 feet, in 2055	Same
Forest Lake	35.26 feet, in 2046	Same
Pinon	15.71 feet, in 2051	Same
Hard Rock	16.10 feet, in 2049	Same
Low Mountain	12.19 feet, in 2055	Same
Shonto Junction	0.23 feet, in 2109	Same
Red Lake	0.09 feet, in 2108	Same
Rocky Ridge	12.08 feet, in 2050	Same
Tuba City	0.01 feet, in 2065	Same
Hopi		
Moenkopi	0.05 feet, in 2096	Same
Hotevilla	2.69 feet, in 2053	Same
Bacavi	2.57 feet, in 2054	Same
Hopi High School	3.73 feet, in 2055	Same
Keams Canyon	5.54 feet, in 2054	Same
Mishongnovi	2.04 feet, in 2057	Same
Second Mesa	1.82 feet, in 2060	Same
Kykotsmovi	2.49 feet, in 2052	Same
Hopi Civic Center	2.77 feet, in 2053	Same
Hopi Cultural Center	2.8 feet, in 2092	Same
Shungopavi	2.0 feet in 2055	Same
Sipaulovi	1.84 feet, in 2056	Same
Polacca	3.89 feet, in 2055	Same
HAMP	11.75 feet, in 2051	Same

[1] If a community has multiple N-Aquifer wells, the value in the table reflects the well with the greatest predicted drawdown.

HAMP = Hopi Arsenic Mitigation Project.

The impact of drawdown due to pumping at the proposed KMC would be to lower the water level in surrounding wells, thereby increasing the amount of lift (in feet) required to bring water to the ground surface. An assessment of the degree of impact at a given well is the percent increase in lift caused by Proposed Action pumping. The percent increase is based on the predicted feet of lift needed at the maximum simulated drawdown from the Proposed Action, compared to the existing feet of lift presently needed under current conditions at each well. **Table 3.7-15** gives the estimated 2019 depth to water in the community wells noted in **Table 3.7-14** at the year of maximum drawdown (including both PWCC and community withdrawals) and the percent increase in lift resulting from the maximum predicted drawdown due to the Proposed Action (PWCC) pumping.

As would be expected given its proximity to the proposed KMC leasehold, the maximum increase in lift due to the Proposed Action pumping would occur at Forest Lake. The range in percent increased lift varies from zero to 3.0 percent; the median value is 0.01 percent. Because of these small values, impacts to future pumping lifts from a Proposed Action operation would be none to negligible.

Table 3.7-15 Percent Increase in Lift at Key Community Production Wells from Mine-Related Proposed Action Pumping

Community	Estimated 2019 Depth to Water (feet bgs) [1]	Anticipated Percent Increase in Lift from Proposed Mine Pumping
Navajo		
Kayenta	820	1.7
Shonto	375	0.0
Dennehotso	32	0.0
Chilchinbito	609	3.0
Rough Rock	727	0.3
Forest Lake	1,145	3.1
Pinon	898	1.7
Hard Rock	785	2.1
Shonto Junction	179	0.1
Red Lake	238	0.0
Rocky Ridge	599	2.0
Tuba City	210	0.0
Hopi		
Moenkopi	616	0.0
Hotevilla	1,002	0.3
Bacavi	1,024	0.3
Low Mountain	833	1.5
Kykotsmovi	280	0.9
Hopi Civic Center	440	0.6
Shungopavi	964	0.2
HAMP[2]	589	2.0

[1] Depth to water is listed for the year of maximum drawdown due to PWCC pumping (see **Table 3.7-14**).

[2] Wells replace existing high arsenic wells at Hopi CC, Polacca, Mishongnovi, and Second Mesa in 2020, and Hopi HS and Keams Canyon in 2030; maximum depth to water occurs after 2030.

HAMP = Hopi Arsenic Mitigation Project.

- Scoping Concern: Proposed pumping could reduce N-Aquifer water quality by increasing leakage from the D-Aquifer across the Carmel Formation.

Impacts to N-Aquifer Water Quality could occur from Leakage Induced from the D-Aquifer by Proposed Mine-Related Pumping, 3-Unit Operation	Impacts to N-Aquifer Water Quality could occur from Leakage Induced from the D-Aquifer by Proposed Mine-Related Pumping, 2-Unit Operation
No N-Aquifer water quality impacts from Proposed Action pumping would occur at NAV wells within the coal lease areas or at wells supplying outlying communities.	Potential impacts would be the same as those described for the 3-Unit Operation.

Since groundwater levels in the D-Aquifer are significantly (100 to 250 feet) higher than in the N-Aquifer, there is a downward hydraulic gradient across the Carmel Formation that separates the two. As described previously, water quality in the D-Aquifer is somewhat poorer than in the N-Aquifer. Thus, reduced N-Aquifer water quality is a potential impact. Generally the aquifer properties of the clay-rich Carmel Formation keep leakage to very small rates near the coal leases, as discussed in the Affected Environment section. This helps maintain good water quality in the N-Aquifer. However, with drawdown occurring in the N-Aquifer from PWCC and community pumping, hydraulic head in the N-Aquifer has declined. This creates an increased downward hydraulic gradient across the Carmel Formation and induces slightly greater flow from the D-Aquifer to the N-Aquifer where leakage occurs. The estimated effects of Proposed Action pumping on water quality (i.e., sulfate concentrations) in the N-Aquifer were simulated as part of the EIS groundwater modeling effort (Tetra Tech 2015a). Available laboratory data were used to estimate the initial sulfate concentrations in both the N-Aquifer and the D-Aquifer. Using the groundwater model cells in each subarea, the new sulfate concentration in the N-Aquifer (for each year modeled) was then determined by adding both the mass of sulfate and volume of water migrating through the Carmel Formation to the mass of sulfate and volume of water in the N-Aquifer during the prior year, and calculating a new sulfate concentration. This approach assumed that the volume of water contained in the N-Aquifer at the beginning of the calculations was large compared to the volume added over the modeling timeframe (Tetra Tech 2015a). As indicated in **Table 3.7-16** below, there is essentially no change in N-Aquifer water quality due to Proposed Action pumping; the very small changes indicated would comprise essentially no Proposed Action-related impacts.

Table 3.7-16 Estimated Change in Sulfate Concentration at the End of 2110 Caused by the Proposed Action Pumping

	Initial Concentration (mg/L)		Predicted Concentration Change (mg/L)[1]	
Subarea	D-Aquifer	Navajo Sandstone	Navajo Sandstone	Navajo Sandstone Change[1]
Northeast	250	70	0.000	0.00033%
East	850	100	0.002	0.00221%
Hopi Buttes	360	50	0.000	0.00007%
Forest Lake	1,000	100	0.003	0.00268%
Kits'illie	75	30	0.000	0.00005%
Pinon	200	5	0.000	0.00078%
Rocky Ridge	250	10	0.000	0.00053%
Preston Mesa	400	10	0.000	0.00000%
Leasehold	400	30	0.004	0.01324%

Table 3.7-16 Estimated Change in Sulfate Concentration at the End of 2110 Caused by the Proposed Action Pumping

Subarea	Initial Concentration (mg/L)		Predicted Concentration Change (mg/L)[1]	Navajo Sandstone Change[1]
	D-Aquifer	Navajo Sandstone	Navajo Sandstone	
Pinon to Kits'illie	1,000	20	0.000	0.00099%
Surrounding Leasehold	100	45	0.000	0.00005%
Red Lake to Tuba City	400	50	0.000	0.00008%
Hotevilla to Kaibeto	200	35	0.000	0.00007%
Pinon to Rocky Ridge	210	140	0.000	0.00004%

[1] Rounding effects account for differences between columns.

Source: Tetra Tech 2015a.

In addition, comparison of recent N-Aquifer water quality data (**Appendix WR-7**) with early 1980s data (PWCC 2012 et seq.) indicates little or no reduction of water quality at wells in the coal leaseholds. N-Aquifer water in PWCC wells meets the standards for intended uses, including drinking water. Although NAV8 has slightly greater TDS concentrations than other NAV wells, it still has very good water quality with respect to drinking water standards. No detectable N-Aquifer water quality impacts from Proposed Action pumping would occur at NAV wells within the coal lease areas or at those supplying outlying communities. Because of this, impacts would be none to negligible.

- Scoping Concern: Regional flow reductions along streams supported by the N-Aquifer may result from proposed mine-related groundwater pumping.

Impacts to Stream Baseflows Supported by the N-Aquifer, 3-Unit Operation	Impacts to Stream Baseflows Supported by the N-Aquifer, 2-Unit Operation
Proposed mine-related pumping would generate either no or negligible reductions to stream baseflows supported by groundwater discharges from the N-Aquifer.	Potential impacts would be the same as those described for the 3-Unit Operation.

Streamflow on Black Mesa results from runoff due to rainfall on the watersheds and from groundwater discharge (baseflow) where aquifer water levels (D-Aquifer and N-Aquifer) intersect stream channels. The D- and N-Aquifers are confined beneath the proposed KMC and over much of Black Mesa, and groundwater discharge from them takes place at or beyond the boundary where the change from confined to unconfined conditions occurs. This is typically around the outer edges of the mesa. The component of streamflow potentially impacted by the proposed KMC pumping, particularly in stream segments supported by the N-Aquifer, is that due to groundwater discharge. This component is referred to as baseflow and is generally stable compared to the runoff from precipitation. Baseflows result from groundwater discharge, and in some stream reaches may be the only source of flowing water in the channel during dry periods. Baseflows are important because they support surface water uses and related habitats during dry periods.

Using the groundwater modeling previously described, stream baseflow at seven locations has been simulated using the MODFLOW Streamflow Routing Package (SFR2). Details of the model, model files, and the USGS review are presented in **Appendices WR-9** and **WR-10**.

Simulated stream baseflow locations are shown at their USGS stream gage locations on **Figure 3.7-13**. Simulated baseflows at the seven model simulated locations are given in **Table 3.7-17** for 1956 (pre-PWCC mining operations) and 2019 (with PWCC mining operations, community, and windmill pumping) (Tetra Tech 2015a,b). The 2019 baseflow values serve as the background condition for the direct and indirect impact assessments for the Proposed Action and alternatives.

The differences between the two values (1956 versus 2019 simulated values) are due to all N-Aquifer pumping (PWCC, community, and windmill) from 1956 through 2019, a total of 63 years. This includes a total historic and projected cumulative withdrawal of 295,695 acre-feet, of which PWCC pumping is 158,684 acre-feet, or 54 percent. Some of the historical baseflow reductions through Year 2019 are the result of pumping (historical and projected through 2019) by PWCC. The total simulated stream discharge in 1956 represented in **Table 3.7-17** is approximately 2.86 cfs. At the end of 2019, summing the negative values in the “Difference” column in **Table 3.7-17** shows that the overall decline (in response to combined community and PWCC pumping) is approximately 0.12 cfs (4.4 percent). Of this overall decline, 0.034 cfs is the total result of pre-2020 PWCC pumping through 2019; this is 1.2 percent of the 1956 simulated streamflow (2.86 cfs). The greatest percentage reduction between 1956 and the end of 2019 is in Polacca Wash, where the simulated effect of all pumping is a reduction of approximately 20 percent (0.025 cfs); the Peabody pumping is estimated to cause a reduction of 6.3 percent (0.0078 cfs) there.

Table 3.7-17 Simulated Baseflow 1956 Compared to the End of 2019 and Predicted Project Effects 2020 through 2110

Location[1]	USGS Station No.	1956 (cfs)	End of 2019 (cfs)	Difference (cfs)	Difference Resulting from pre-2020 PWCC Pumping (cfs)	Predicted Mine-Related Changes, 2020 through 2110 (cfs)
Moenkopi Wash	09401260	1.641	1.637	-0.004	-0.0027	-0.0004
Dinnebito Wash	09401110	0.198	0.200	0.002	0.0000	0.0000
Polacca Wash	09400568	0.124	0.099	-0.025	-0.0078	-0.0007
Chinle Creek	09379200	0.348	0.309	-0.039	-0.0105	-0.0027
Jeddito Wash	09400583	0.063	0.062	-0.001	-0.0001	0.0000
Begashibito Wash	NA	0.119	0.101	-0.018	-0.0028	0.0000
Laguna Creek	09379180	0.364	0.326	-0.038	-0.0104	-0.0027

[1] Locations are indicated on **Figure 3.7-13**.

cfs – cubic feet per second.

NA – Not Applicable – No USGS gage at this location.

For the Proposed Action, PWCC pumping would start after the end of 2019, and would consist of the annual pumping volumes for the Proposed Action options previously listed in **Table 3.7-13**.

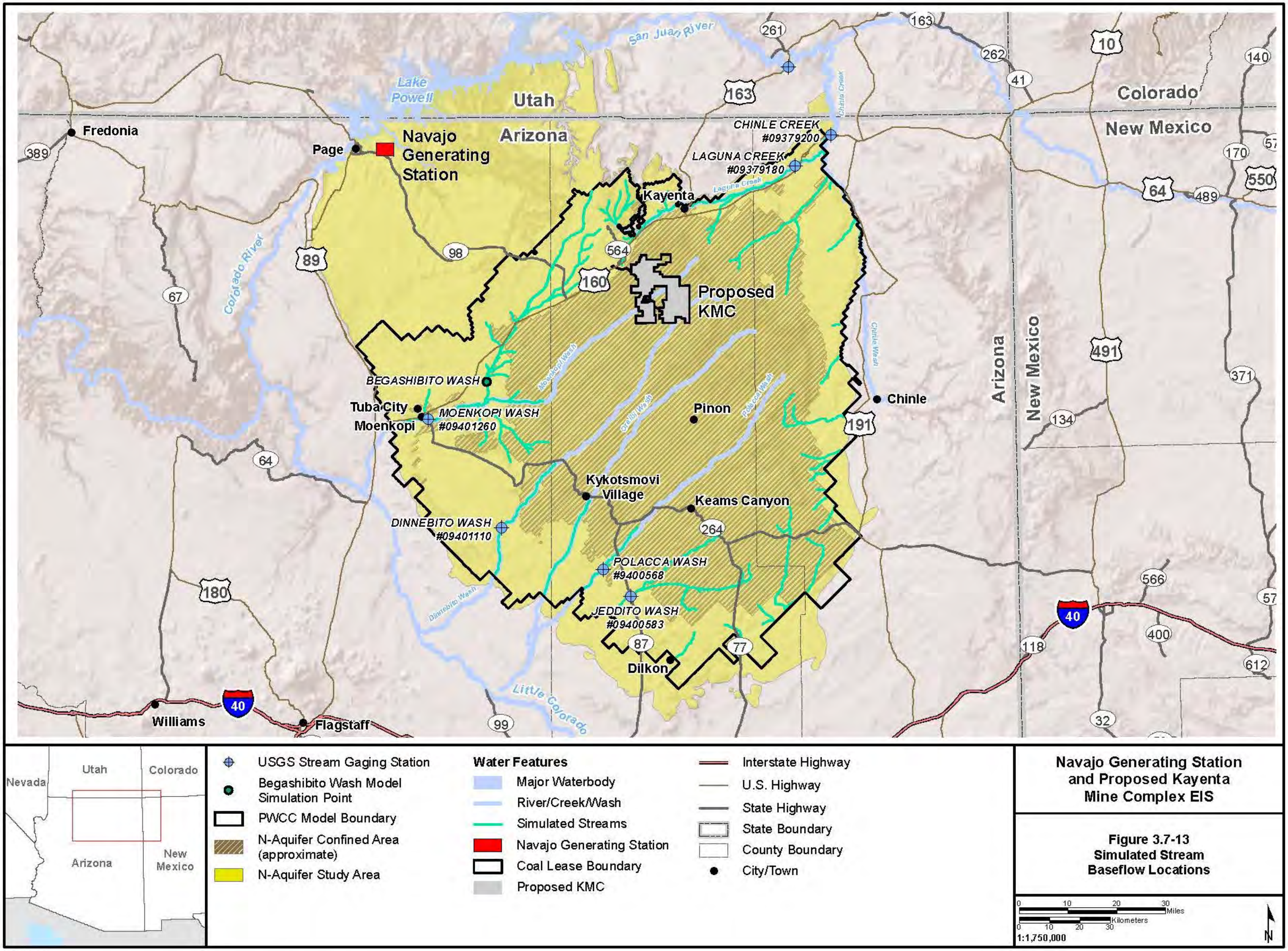


Figure 3.7-13
Simulated Stream Baseflow Locations

8/22/2016

Over the projected 2020 through 2110 period, either the total PWCC 3-Unit Operation or the 2-Unit Operation pumpage is predicted to be about 32,500 acre-feet. This would be 20 percent of the historic PWCC pumping and 11 percent of the total 1956-2019 pumpage from all regional sources (by the mining operation and communities). The effects of the Proposed Action were determined by calculating the differences between pumping for the Proposed Actions and for the No Action Alternative (discussed below) at the beginning of 2020 and the end of 2110. Future total reductions from the Proposed Action (0.0065 cfs, summing the right-most column of Table 3.7-17) are predicted to be smaller than the pre-2020 reductions (0.034 cfs), by a factor of 0.19. The washes with the largest percentage reduction between 2020 and 2110 are Chinle Wash (0.87 percent or 0.0027 cfs) and Laguna Creek (0.83 percent or 0.0027 cfs).

Based on the groundwater modeling results summarized in **Table 3.7-17** above, PWCC mine-related Proposed Action pumping would have no effect on background channel baseflows in Dinnebito Wash, Jeddito Wash, or Begashibito Wash. There would be almost no mine-related effect on background flows in Moenkopi Wash, and less than one percent change in Polacca Wash, Chinle Creek, or Laguna Creek as a result of mine pumping. These would be negligible effects.

- Scoping Concern: Flows at springs or the occurrence of seeps could be reduced by mine-related pumping at the proposed KMC (D- and N-Aquifers)

Impacts to N-Aquifer Springs from Proposed Mine-Related Pumping, 3-Unit Operation	Impacts to N-Aquifer Springs from Proposed Mine-Related Pumping, 2-Unit Operation
Proposed mine-related pumping would generate either no or very small reductions in flows or water levels at N-Aquifer springs. The potential impacts from either Proposed Action options would be none to negligible. PWCC has already closed or is reclaiming wells open to the D-Aquifer; no impacts to D-Aquifer springs would occur from proposed mine-related pumping. Based on the analysis of spring features, impacts to seeps also would be negligible.	Potential impacts would be the same as those described for the 3-Unit Operation.

As noted in the Affected Environment description, D- and N-Aquifer springs and seeps occur where the aquifer rocks are exposed, and the aquifer water level is at or above the land surface. In most cases these conditions are limited to the periphery of the mesa where the aquifer units are at or near the ground surface. Since springs and seeps are important perennial water sources for irrigation, cultural, and ecological purposes, and have religious or sacred values for the Navajo and Hopi people, individual spring locations are not identified in the EIS unless they have been identified in the published literature (e.g., the four USGS monitored springs: Pasture Canyon, Moenkopi School/Susunova, Burro, and Unnamed near Dennehotso).

The USGS undertook a study to identify and characterize springs identified by various methods (Leake et al. 2016). A total of 104 springs characterized as “likely” were identified as emanating from D- and N-Aquifer stratigraphic units. With the exception of the four USGS monitored springs, individual sites were not visited and no flow data are available. To facilitate the discussion of impacts of proposed mine-related pumping on springs and seeps, these features were grouped into major areas (“A” through “J”) based on their geographic and hydrogeologic similarity. Spring and seep groups are shown on **Figure 3.7-14** and briefly described in **Table 3.7-18**. Additional spring information is presented in **Appendix WR-10.**

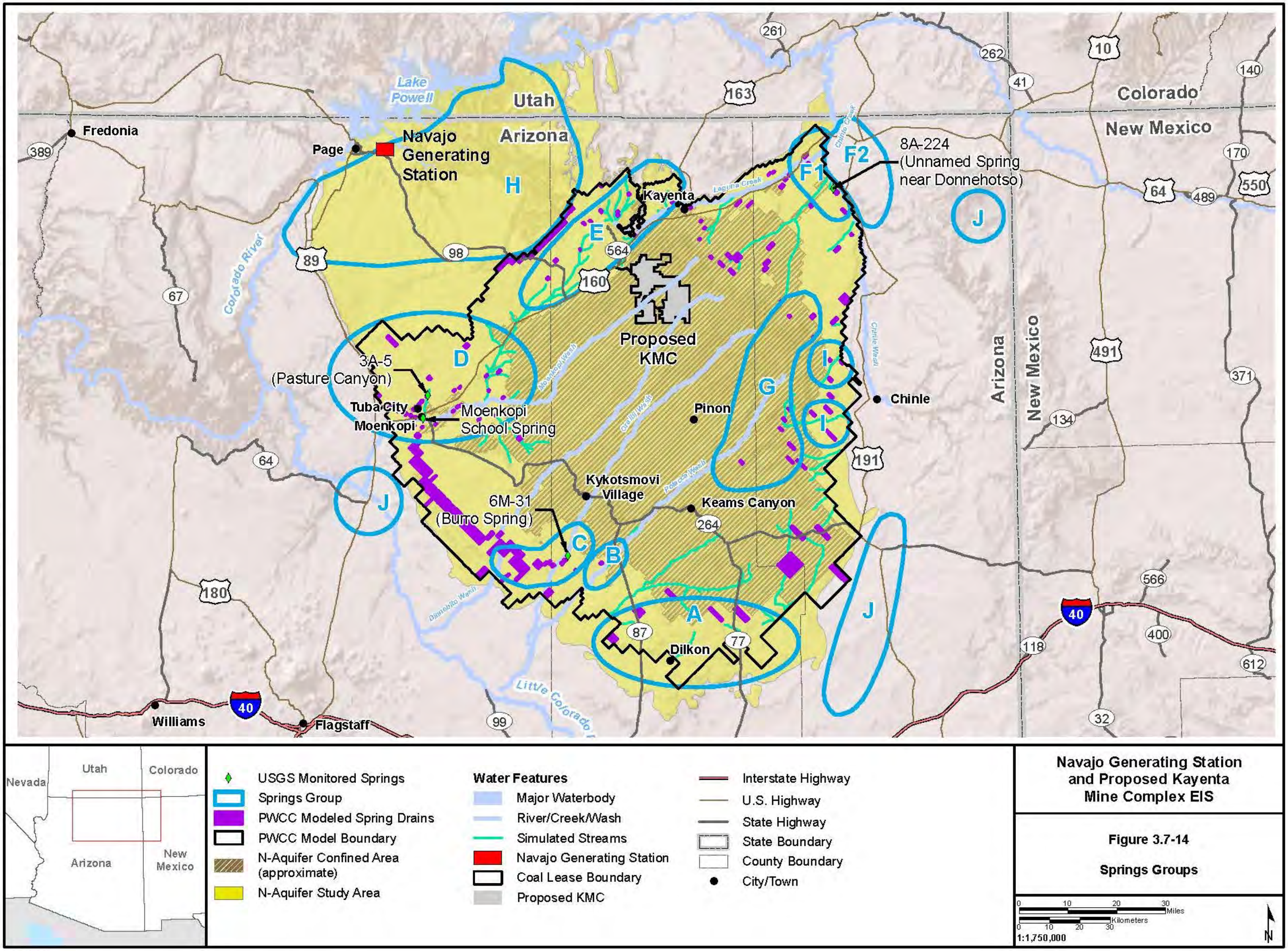


Figure 3.7-14

Springs Groups

7/20/2016

Table 3.7-18 Spring Groups Developed for Discussion Purposes

Spring Group	Number of Springs/Seeps	Location
A	8/0	Located in the Dilkon area
B	3/0	Near Polacca Wash
C	9/1	Near Oraibi Wash, includes USGS Monitored spring (Burro)
D	21/0	Near Tuba City, Moenkopi Wash and Blue Canyon; includes USGS-monitored springs (Pasture Canyon and Moenkopi School)
E	10/1	Near Shonto Wash
F1	10/0	Near Dennehotso, west side of Chinle Wash, includes USGS monitored spring (Unnamed)
F2	7/0	Near Dennehotso, east side of Chinle Wash. Outside PWCC model
G	2/1	East of Pinon, N-Aquifer thin, D-Aquifer springs
H	21/0	Kaibeto Plateau in incised canyons. Outside PWCC model
I	2/0	Near Chinle west of Chinle Wash
J	6/0	Miscellaneous, outside N-Aquifer. Outside PWCC model

As with the impact of proposed mine-related pumping on wells, the PWCC 3-D groundwater flow model is utilized to evaluate potential changes at springs and seeps due to future pumping at the proposed KMC. Model calibration targets included water elevations at springs and in wells for both the D- and N-aquifers. USGS-monitored springs are listed in **Table 3.7-19** along with the 2012 measured and modeled flow. Groundwater elevations at the springs also were modeled, and potential changes in elevations also are used in the assessment. The locations of these springs are shown on **Figure 3.7-14**.

Table 3.7-19 PWCC Model Calibration Springs

Name	USGS ID	BIA ID	2012 Measured Flow (gpm)	2012 Model Simulated Flow (gpm)
Moenkopi School	360632111131101	3GS-77-6	6.3	0.0[1]
Burro	354156110413701	6M-31	0.3	0.0[1]
Pasture Canyon [2]	09401265	3A-5	150	122
Unnamed near Dennehotso	364656109425401	8A-224	4.5	3.5

[1] Although simulated by the MODFLOW SFR2 package, zero flow was produced at the spring locations (see text).

[2] Pasture Canyon springs as estimated for the sum of discharge.

BIA = Bureau of Indian Affairs

The PWCC model simulates these monitored springs using the MODFLOW Streamflow Routing Package (SFR2). The other non-monitored springs do not have consistently measured flows; the model is not calibrated to discharge values at these locations; these springs are represented by drain cells. The stream flow routing package generates a flow value for the four monitored springs given in **Table 3.7-19**. As noted, zero flow was produced by the model at the Moenkopi School and Burro Spring sites. This is thought to be due to complexities in the local geologic environment and the limitation of vertical discretization to simulate these complexities at these locations (Tetra Tech 2014).

Moenkopi School (Susunova) Spring is located in a tongue of the Navajo Sandstone within the Kayenta Formation (**Appendix WR-10**). The Navajo Sandstone and Kayenta Formations are simulated as individual layers in the model and have significantly different hydrologic parameters. Thus, the Moenkopi Spring is simulated as though it were in the Kayenta Formation with lower conductivity and produces no flow at the spring. Burro Spring occurs within the Navajo Sandstone, but appears to be locally perched within the formation; the model is unable to simulate flow in sublayers of the formation since it is simulated a single layer. However, in both cases the model does simulate heads (water levels) at the location of the springs. A decrease in water level would result in a corresponding decrease in spring flow. Therefore, model predicted changes in head provide a surrogate for potential impacts to spring flow. Model-predicted changes in both water levels (and springs) due to Proposed Action pumping are very small, e.g., less than 0.01 foot changes in water levels.

No change in flow at the four USGS monitored springs is predicted as a result of the proposed mine-related pumping under either the 3-Unit Operation or 2-Unit Operation. As depicted on **Figure 3.7-15**, the cone of depression due to proposed mine-related pumping would be largely limited to the confined area of the N-Aquifer where aquifer storage coefficients are small. Once the cone of depression reaches the unconfined portions of the aquifer where storage coefficients are orders of magnitude higher than in the confined aquifer, the spread of the cone of depression is significantly reduced. The monitored spring locations are within the unconfined portion of the aquifer and distant from the confined/unconfined boundary.

A total of 98 non-monitored springs and seeps are represented by drain cells in the PWCC model. Due to model limitations, not all drain cells that were used to simulate non-monitored springs produced a flow rate. Since flow is proportional to change in head, to evaluate any potential change in flow at these locations the model-predicted change in head (drawdown) due to mine-related pumping was determined.

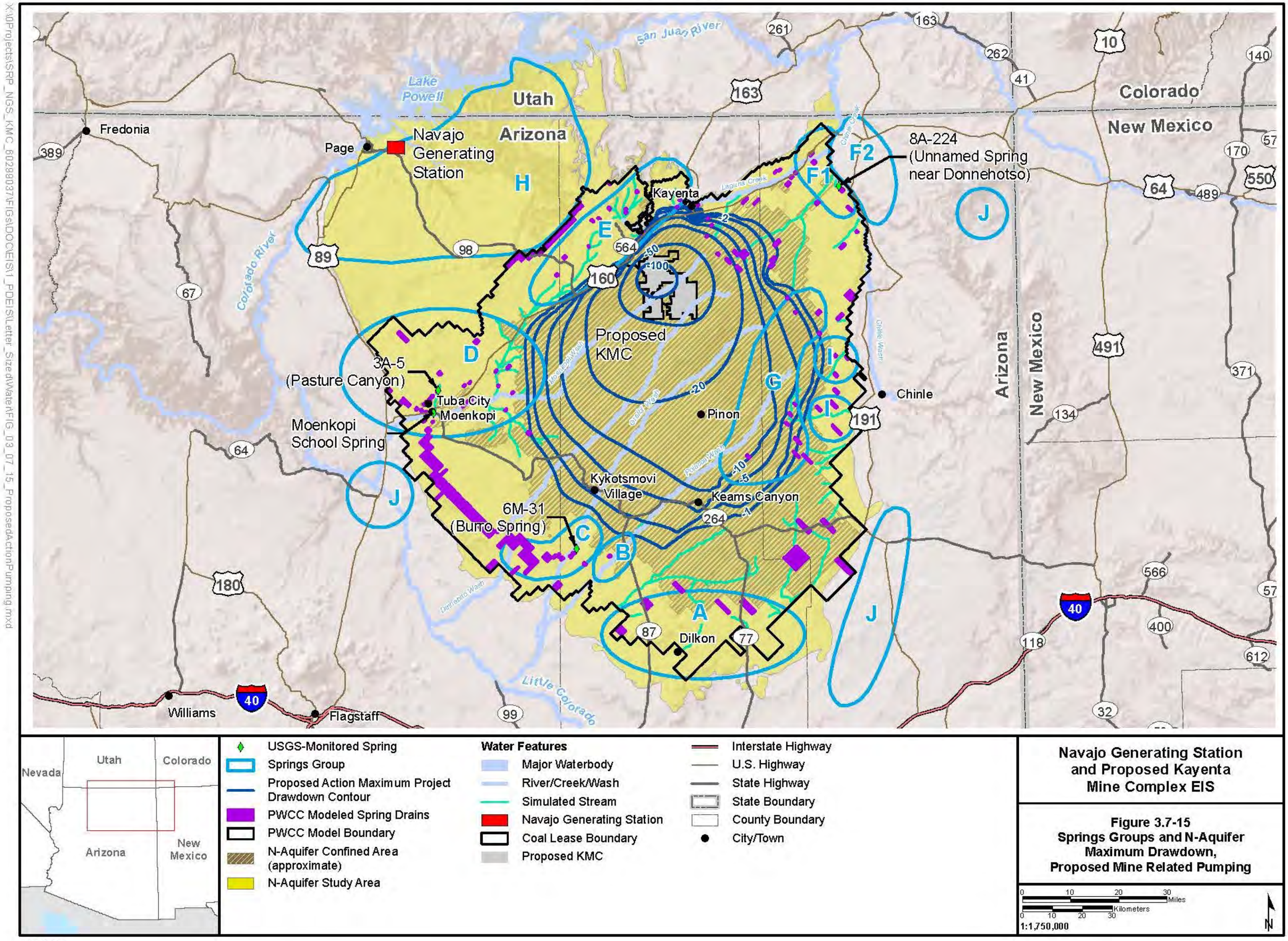
Predicted effects on simulated water levels caused by mine-related pumping were noted even if no flow at the spring was modeled. Model predicted maximum impacts to non-monitored springs and seeps are given in **Table 3.7-20**, below.

Table 3.7-20 Maximum Impact at Non-Monitored Springs Due to Mine-Related Pumping, Proposed Action [1]

Group	Number of Springs in Model	Maximum Impact Due to Proposed Action Mine Pumping [1]
A	8	No head or flow change
B	3	-0.002 feet head change at 1 spring; no flow change
C	9	Head change -0.001 to -0.013 feet at 2 springs; no flow change
D	19	Head change -0.001 to -0.23 feet at 2 springs; -0.0005 gpm flow at 1 spring
E	11	Head change -0.002 to -0.019 feet at 2 springs; no flow change
F1	9	Head change -0.001 feet at 3 springs; -0.00003 gpm at 1 spring
G	3	Head change -0.01 to -0.009 feet at 2 springs; no flow change.
I	2	Head change -0.006; -0.0003 gpm at 1 spring

[1] No impacts would occur to springs within the model boundary that have zero head change and are not noted in the table.

A number of USGS ‘likely’ springs are located outside the PWCC model boundary, including those in Groups F2, H and J, as shown on **Figure 3.7-15**. Given the distance of these springs and seeps from the proposed KMC leasehold water supply wells, and the small head and flow change at closer springs within the model boundary (**Table 3.7-20**), impacts at these spring and seep locations is negligible.



Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 3.7-15
Springs Groups and N-Aquifer Maximum Drawdown, Proposed Mine Related Pumping

Head and/or flow change is limited to a small number of springs in each group and ranges between none to -0.23 feet and none to -0.06 gpm. As noted previously, these springs and seeps are in the unconfined portions of the N-Aquifer, and outside the 1.0 foot drawdown contour predicted for the Proposed Action mine-related pumping. Springs issuing from the D-Aquifer are isolated from proposed mine pumping and would not be affected by either Proposed Action operation. Because proposed mine-related pumping would generate either no or very small reductions in flows or water levels at D- and N-Aquifer springs and seeps, the potential impacts from either Proposed Action options would be negligible.

3.7.4.2.2.2 D-Aquifer Uses

- Scoping Concern: Pumping withdrawals from the N-Aquifer may be reduced by developing a new D-Aquifer water supply for mining and reclamation activities. This might improve the long-term sustainability of the N-Aquifer.

Effects of a D-Aquifer Partial Water Supply for the Proposed KMC, 3-Unit Operation	Effects of a D-Aquifer Partial Water Supply for the Proposed KMC, 2-Unit Operation
Low D-Aquifer productivity would limit its usefulness as a partial proposed KMC water supply. A large number of new wells and a new distribution infrastructure would be required; associated costs would be economically prohibitive. Pumping drawdowns would occur at windmills and some existing community wells. The reduction of anticipated combined N-Aquifer withdrawals would be minimal. Because of these factors, a partial D-Aquifer water supply at the proposed KMC is not considered further.	Factors and effects would be the same as those described for the 3-Unit Operation.

Based on project scoping input from agencies and the public, the EIS assessed the possibility of using D-Aquifer wells and groundwater withdrawals to provide part of the water supply at proposed KMC. Even if D-Aquifer wells were constructed, some N-Aquifer withdrawals would still be needed to support potable uses and sanitation. If developed, a new D-Aquifer supply also would need a separate distribution system due to its lower water quality. Evaluating a D-Aquifer partial supply for the EIS involved three major aspects: the technical capability of the D-Aquifer to provide adequate volumes of suitable water for mine uses, the economics involved in constructing a D-Aquifer wellfield, and the effects of such an effort on water resources.

<u>Technical Aspects</u>

Source location, adequate volume, and suitable water quality are the major technical considerations. Of course, the amount of water needed at the mine depends on its uses and the suitability of the source to meet those uses. As described in Section 3.7.3.1, the water quality of the D-Aquifer is marginal to unsuitable for potable or other uses (e.g., equipment washing) that occur at the mine. Therefore, existing N-Aquifer water would still be required to meet those uses at the mine, and to fulfill existing and future public water supply agreements for local tribal users. Additional acre-feet per year from the N-Aquifer would be required to supply the separate Many Mules project on the Navajo Nation from existing PWCC N-Aquifer well NAV2, but this is not part of the proposed demand for mine-related uses (Tetra Tech 2015a,b). This further demonstrates the need for maintaining an N-Aquifer water system.

Pumping demand at the proposed KMC during the period 2020 through 2044 is estimated to be approximately 1,200 acre-feet per year from the N-Aquifer. For purposes of this D-Aquifer substitute supply assessment, it is assumed that roughly 100 acre-feet/year of high-quality N-Aquifer water would still be needed for domestic and other uses at the mine, and to supply local public potable water needs. This is based on an estimate of high-quality potable water requirements for 516 mine employees and contractors, plus other facility uses requiring a similar supply, and an assumed 100 local tribal individuals that each use 100 gpd for domestic and miscellaneous uses from public water stands.

The average water quality of the D-Aquifer as reported in Section 3.7.3.1 would probably be suitable for dust suppression, fire suppression, or similar applications. Of the approximately 1,200 acre-feet per year estimated as pumping demand at the mine through 2044, there remain approximately 1,100 acre-feet per year of that projected demand that could be provided by lesser-quality D-Aquifer water. From 2044 to 2047, mine demand would drop to 500 acre-feet per year, of which it is estimated 100 acre-feet per year of potable water would continue to be needed. From 2048 and after, mine demand would drop further to about 100 acre-feet per year, most of which would consist of non-potable uses.

As part of the technical review, PWCC and its groundwater modeling contractor (Tetra Tech) were asked to simulate pumping from a hypothetical D-Aquifer wellfield at the mine, using known or estimated aquifer characteristics (e.g., depth, hydraulic conductivity, transmissivity). Results of this effort were carried forward into this assessment.

Because of limited data on water-level responses to D-Aquifer pumping in the locale, there are uncertainties in the hydraulic conductivity and storage properties for the D-Aquifer. As a result, there are uncertainties in the model predictions of water-level changes in the D-Aquifer from a pumping scenario. Based on limited testing from the 1960s, compared to more recent model calibrations, the model may over-predict the productivity of the hypothetical wells. The scenario investigated used the estimated well productivity based on the modeling work. However, because of the lack of information, there is a significant question about the ability of the D-Aquifer to provide the needed water (Tetra Tech 2015a,b).

In a hypothetical four-well D-Aquifer supply field, where all four wells would be built and operating in 2020, modeling results indicated the following:

- Well D2 (located at NAV2) could produce about 230 acre-feet per year initially, but would drop to about 210 acre-feet per year in 2044;
- Well D6 (located at NAV6) could produce 300 acre-feet per year for about five years, but would drop to about 240 acre-feet per year in 2044;
- Well D8 (located at NAV8) could initially produce about 220 acre-feet per year, decreasing to about 205 acre-feet per year in 2044; and
- A simulated well near the J28 coal resource area could produce about 240 acre-feet per year initially, but would drop to about 150 acre-feet per year in 2044.

Results from this exercise indicate that four D-Aquifer wells initially could produce about 990 acre-feet per year. In the year 2033, about halfway through the proposed major pumping duration, production from four D-Aquifer wells would drop to about 840 acre-feet per year. By 2040 about 810 acre-feet per year could be produced. These are insufficient supplies for the mine needs of about 1,100 acre-feet per year. Also, these results are based on the significantly more productive model inputs, compared to those indicated by limited testing in the 1960s. The D-Aquifer could be less productive than inputs used in modeling. As a result, anywhere between 5 to 10 (or more) D-Aquifer wells would be needed to meet estimated non-potable demands at the mine until 2044. As mentioned previously, from 2044 to 2047, mine demand would drop to 500 acre-feet per year. In 2048 and after, mine demand would drop further to about 100 acre-feet per year. These lower demands would reduce the number of D-Aquifer wells needed after 2044, approximately 25 years after the start of the Proposed Action.

Economic Aspects

Assuming the studies determine there would be sufficient volumes of D-Aquifer water that could meet the non-potable needs of the proposed KMC, and the impacts from such pumping were found to be acceptable, the associated costs to develop each production well is estimated to be about $1.1 million. This is a rough estimate based upon an itemized 2007 cost estimate to construct, test, and plumb out an adequate N-Aquifer supply well on Black Mesa, which was approximately $1.3 million (John 2016).). Based on this, an estimated cost to construct, test, and plumb out a shallower D-Aquifer supply well in the locale would be approximately $976,000 in 2007 dollars ($1.13 million in 2016 dollars). Cost changes since then would increase that estimate. A total estimated cost for five to ten D-Aquifer wells would range from roughly $5.5 million to $11 million in 2016 dollars. Substantial additional costs would be incurred by an independent infrastructure that would be required to keep D-Aquifer water separate from potable N-Aquifer supplies. Operation, maintenance, and testing costs also would be incurred, but could be offset somewhat by reduced activities at existing N-Aquifer wells. However, the N-Aquifer distribution system would still need to be operated and maintained, and pursuant to existing lease terms PWCC would be required to continue exercising (pumping) the N-Aquifer wells periodically to maintain their long-term operational viability.

Prior to being able to make any decision regarding use of D-Aquifer water to meet the non-potable water needs of the proposed KMC, extensive investigations would need to be conducted to provide better estimates of available volumes and pumping impacts from the operation of a proposed D-Aquifer well field, to meet the non-potable uses of the proposed KMC. These would entail drilling and pump testing a number of monitoring wells, and additional modeling using the pump test results. These investigations could take up to a year to complete. Assuming the results of these investigations indicated sufficient water could be provided by a D-Aquifer non-potable water supply system, additional environmental compliance would be required prior to final design and construction of a D-Aquifer wellfield and delivery system. This environmental compliance process could add another 0.5 to 1.5 years to the front end of wellfield development, at an estimated cost of $50,000 to $300,000.

If a D-Aquifer wellfield was in operation by the Year 2020, it would be in service for approximately 25 years. Under such highly conjectural circumstances, approximately 27,500 acre-feet of N-Aquifer water would be conserved through the Year 2044 by substituting D-Aquifer water for non-potable uses at proposed KMC. This assumes a substitution rate of 1,100 acre-feet annually. Given all the unknowns and due to fiscal considerations, however, it is more likely that the entire wellfield would not be in service by the Year 2020 and some or most of the period between 2020 and 2044 (when most pumping would occur) would have elapsed. In those conditions, the amount of N-Aquifer water conserved during the Proposed Action would be less, since N-Aquifer pumping would still be needed while the D-Aquifer wells were being built.

Resulting Effects

Using inputs and results from modeling, a D-Aquifer wellfield at the mine would create aquifer drawdown (water level declines in D-Aquifer wells) primarily in and near the coal leasehold. These results are based on the D-Aquifer characteristics used in modeling, which may be over-optimistic. Uncertainties exist regarding D-Aquifer hydraulic characteristics and productivity D-Aquifer drawdowns of approximately 50 to 100 feet were simulated in the coal lease area by the end of 2044, and would continue into 2057. These contours would be generally concentric, centering around the northwestern part of the KMC. By 2044, a roughly similar concentric 10-foot drawdown contour would extend in the aquifer past Forest Lake, and a 1-foot decline in D-Aquifer well water levels would extend to Pinon, Kits'illie and Chilchinbeto. Simulations indicated that declines in D-Aquifer water levels would increase to roughly 15 to 20 feet at Forest Lake at the end of 2057, but would remain at about 1 foot at Pinon, Hard Rock, or other communities. By the end of 2110, water level recovery in D-Aquifer wells would leave a small remnant of ten-foot decline at the south end of the coal lease area, with less at Forest Lake. Approximately 1 foot of drawdown would extend to Hard Rock, Pinon, Kits'illie, and Chilchinbeto (Tetra

Tech 2015a). Under a D-Aquifer pumping scenario, resulting N-Aquifer drawdowns would be less than under the Proposed Action: approximately one foot in the vicinity of the coal leases, Forest Lake, and Chilchinbeto in 2044 and 2057.

Windmills and community wells sourced from the D-Aquifer between the coal leases and communities such as Hard Rock, Pinon, Forest Lake, and Chilchinbeto would be affected by these various water level declines. If a substantial part of the community well at Forest Lake is open to the D-Aquifer as suspected, then some drawdown would occur in that well. With Proposed Action pumping, some declines in community well productivity are predicted to occur at Kayenta, Low Mountain, and Spider Mound in approximately 2095 to 2016 (Tetra Tech 2015a). These locations would not be affected by D-Aquifer pumping. Livestock wells would be affected by D-Aquifer drawdowns of 50 to 100 feet within or near the coal leasehold (Tetra Tech 2015a). Livestock wells would be affected by about 20 feet of drawdown south of the leasehold to near Forest Lake, and for 2 to 4 miles outside the north, east, and west leasehold perimeters.

Simulated effects on N-Aquifer springs and streamflows indicate no discernible differences between the Proposed Action (N-Aquifer) pumping at proposed KMC and a substitute D-Aquifer supply (Tetra Tech 2015a). There would be no difference between D-Aquifer pumping and proposed N-Aquifer pumping with respect to effects on baseflows in major channels such as Moenkopi Wash, Dinnebito Wash, Begashibito Wash, and others. Similar results also would occur at N-Aquifer springs. There are few, if any, D-Aquifer springs within the anticipated drawdown extent of either pumping scenario; therefore, spring effects would be negligible to minor.

After 2005, recent PWCC pumping has represented approximately 30 percent of the total combined N-Aquifer pumping. During the Proposed Action, mine-related N-Aquifer pumping would comprise continually declining proportions of the anticipated total annual demand on the N-Aquifer. The total projected N-Aquifer pumping volume for the Proposed Action is predicted to be approximately 32,500 acre-feet, or about 3 percent of the total anticipated 2020 to 2110 cumulative pumping from the N-Aquifer (including the mine and estimated community demands). Mine-related N-Aquifer withdrawals would comprise approximately 12 percent of total anticipated cumulative pumping from 2020 through 2057, when proposed PWCC pumping would cease. Thus, the benefit of reducing pumping from the N-Aquifer by using water pumped from D-Aquifer wells would be limited and would not warrant use of the D-Aquifer as a substitute water supply.

Implementing a D-Aquifer supply scenario at proposed KMC would have significant impacts on economic factors related to either Proposed Action options. At the same time, benefits to the N-Aquifer would be limited, given that a number of years or decades would be needed to complete a D-Aquifer wellfield compared to the timeframe of the Proposed Action. Over time, proposed mine-related pumping would be a diminishing factor compared to other N-Aquifer withdrawals. Because of these aspects, a substitute D-Aquifer water supply at proposed KMC is not further considered in the EIS.

3.7.4.2.2.3 Wepo Aquifer Water Levels, Water Quality, and Uses

- Scoping Concern: Mine pit development and reclamation could create groundwater drawdown in the Wepo Formation and reduce supplies to wells, springs, and alluvium.

Impacts from Reduced Wepo Formation Groundwater Quantities within the Coal Lease Areas from Mining Activities, 3-Unit Operation	Impacts from Reduced Wepo Formation Groundwater Quantities within the Coal Lease Areas from Mining Activities, 2-Unit Operation
Negligible effects to well water levels or overall groundwater quantities in the Wepo Formation or connected springs and alluvium would occur. PWCC would continue to mitigate impacts that may occur.	Effects would be the same as those described for the 3-Unit Operation.

Recent water levels in Wepo Formation monitoring wells indicate the greatest water level changes (over 4 feet during the 2010 through 2014 period) are recorded in six wells: WEPO41, WEPO43R, WEPO44, WEPO52, WEPO53, and WEPO67(**Appendix WR-5**, **Table WR-5.1**). For the period 2010 through 2014, the greatest individual water level changes occur at WEPO52, which had a maximum rise of 2.0 feet, and a maximum decline of 5.6 feet. The other five listed wells had water level rises between about 1 to 2 feet, and declines between about 1 to 4 feet during the period. Water level changes were smaller in the other 17 Wepo wells with complete annual data in the table. Generally these smaller changes were less than about 0.7 feet rising or falling over the 5-year period. All water level comparisons are based on the deepest recorded levels each year, which is a conservative approach. These variable water level conditions (rises and declines) would continue in the Wepo Aquifer under a Proposed Action option, as further discussed below.

Early data for depths to water in the Wepo Formation are recorded for wells WEPO49, 54, 65, 66, and 67 during the period 1980 to 1984. In 2014 by comparison, the water level in WEPO49 was 8.4 feet higher than its greatest level during the 1980-1984 period, and it was 4.0 feet higher than its shallowest recorded level. Recent water levels at WEPO54 remained approximately at the middle of their range from the early baseline (1980 to 1984) period. At WEPO65, recent (2010 through 2014) levels approximated the deepest value for most of the 5-year period, but then declined an additional 1.4 feet in 2014. Recent levels in WEPO66 were well within their historic range from 1980 to 1984. At WEPO67, recent levels remained 25 to 30 feet shallower than their deepest level in 1980 to 1984, but were somewhat deeper than the middle of the recorded historic range. Future mining may lower water levels in adjacent Wepo wells, as has occurred in the past at wells such as WEPO62 (68.6 feet deeper) and WEPO53 (16.1 feet deeper) (PWCC 2012 et seq.). However, at other wells (e.g., WEPO40, 42, 43R, and 44), adjacent mining resulted in little or no effects to water levels. Groundwater has been rising in these four wells since 2010, and did not decline from historic background levels.

In the Proposed Action option, groundwater drawdown in the Wepo Formation would depend on pit configurations in relation to water-bearing zones, as it has in the past. Based on the data described above, variable fluctuations would occur in Wepo Formation water levels over the life of either Proposed Action options. Water levels would decline at a few wells, remain within their former ranges at most wells, and rise at others. These conditions generally reflect the isolated, perched water-bearing zones characteristic of the formation, and its responsiveness to variations in climate and recharge. From existing data, it is likely that most Wepo wells would maintain water levels within their historic ranges under a Proposed Action option. Based on the isolated, limited lateral extents of water-bearing zones in the Wepo Formation, any drawdown effects that may occur would probably extend less than 1 mile or so from proposed mining. If these impacts occurred, they would be of a minor, highly localized nature due to formation characteristics and the natural variability typical of Wepo Formation water levels.

There are approximately 18 existing privately used local wells within the coal lease areas or in the general area (PWCC 2012 et seq.). Some of these do not appear to be in use. Since the Wepo Formation is not very productive, construction information gathered by PWCC indicates that most of these wells are supplied from sources other than the Wepo Formation, such as alluvium or the Toreva or Dakota formations (PWCC 2012 et seq.). Six Wepo wells remain in or within about 3 miles of the leasehold (4K-380, 4K-389, 4T-405, 4T-512, 8A-PHS-15, and W00236110-D.24). Historically, other wells (8T-506, a Wepo well, and 4T-403, a Toreva well) were previously removed during the course of mining. Existing well 4T-404 (a Toreva well) would be removed during mining in the J-19 area. PWCC is required to repair or replace water supplies in accordance with Surface Mining Control and Reclamation Act regulations. Because of this, combined with the limited extent of potential mine-related drawdown effects and the natural variation of Wepo Formation water levels, no impacts to existing Wepo or Toreva water supplies would occur from either Proposed Action options.

The variation in Wepo Formation water levels is expected to contribute to variable springflows and alluvial water levels. With respect to shallow spring sources, flows at some Wepo springs in the leasehold that are in or near alluvial channels or near active mining have maintained their historical flows (e.g., Natural Spring [NSPG]22, NSPG61; **Appendix WR-3, Figure WR-3.1**), and a new spring (NSPG64) developed along lower Coal Mine Wash. Natural Springs are those determined to be a pre-existing spring (i.e., noted prior to the onset of mining activity), or not connected in any way to either mining or any other human activity. Flows at another spring (NSPG21) went dry. Springs in alluvial settings in the former Black Mesa Mine area (NSPG561, 562, 563) have maintained flows typical of their ranges measured since 2007. These interactions and their results would continue under a Proposed Action option. Wepo groundwater contributions to alluvial water levels were briefly mentioned in the previous alluvial aquifer discussion. Alluvial water levels from 2010 through 2014 indicate that conditions at background alluvial wells varied from year-to-year, and changes (rises or declines) were inconsistent between wells. An overall decline in water levels at background alluvial wells occurred during the period; effects that were primarily driven by drought and not by mining. To re-iterate, monitoring data indicate that within the coal lease areas, local alluvial water levels may rise or fall during such overall declines. Locally, these variations would be affected by the anticipated variable changes in Wepo well water levels, and importantly, changes in precipitation.

While minor local reductions may occur, little or no overall impacts to hydrologic conditions or water use in the leasehold would occur from mining impacts to Wepo Aquifer groundwater quantities under either Proposed Action options. Overall mine-related impacts would be negligible This conclusion is based on the variable but generally limited amount of drawdown in Wepo monitoring wells, the generally small flows from monitored springs, and the comparatively few wells that are supplied by the Wepo Formation or connected alluvial groundwater. As mentioned, PWCC has mitigated impacts to these resources in the past with replacement water supplies from wells or ponds. Under a Proposed Action option, PWCC would continue to offset any impacts to designated and foreseeable water uses through water supply replacement within the proposed KMC, in accordance with federal regulations (OSMRE 2011a).

- Scoping Concern: Water quality in the Wepo Formation and hydrologically connected springs and baseflows could be reduced by mining and reclamation activities.

Impacts of Reduced Wepo Formation Groundwater Quality from Mining and Reclamation Activities, 3-Unit Operation	Impacts of Reduced Wepo Formation Groundwater Quality from Mining and Reclamation Activities, 2-Unit Operation
In addition to natural processes, mining and reclamation would continue to locally elevate TDS and sulfate concentrations in Wepo Formation groundwater and in hydrologically connected springs and stream baseflows. These would be localized, minor impacts. Ongoing PWCC mitigation in the form of permanent ponds and impoundments would maintain existing local water uses consistent with present conditions.	Potential impacts would be the same as those described for the 3-Unit Operation.

Background water quality in the Wepo Formation is monitored at wells WEPO55, 56, 57, 59, 61, 65, 67, 69 (**Appendix WR-5, Figure WR-5.1**). All but the last three are in the former Black Mesa Mine area, where no further mining is proposed. Recent water quality characteristics are summarized for these background wells in **Appendix WR-5**, and were briefly described in the respective Affected Environment discussion. Background trace element concentrations were low except for boron, which remained well within the livestock watering benchmark. Comparisons between Wepo Formation wells indicate that trace elements remained at low levels in background Wepo wells as well as those that may be affected by mining. Because of this, trace element impacts from mining activities would not occur or would be negligible in Wepo Formation water quality under either Proposed Action options.

In general, TDS and sulfate concentrations typically increased at Wepo wells that were likely affected by mining activities. It should be noted that these increases, although they can represent large percentage changes from typical sulfate and TDS values at background wells, still remain within the recommended livestock watering values used as benchmarks. For example, for all background wells, recent median sulfate and TDS concentrations (**Appendix WR-5, Table WR-5.7**) are 168 and 862 mg/L, respectively. In the northwest mining locale, recent median values are 760 and 1,370 mg/L for sulfate and TDS, respectively (**Appendix WR-5, Table WR-5.3**). Recent median sulfate and TDS values in the northeast mining locale are 513 and 1,665 mg/L, respectively (**Appendix WR-5, Table WR-5.4**). Recent median values in the former Black Mesa mine area are 475 and 1,505 mg/L for sulfate and TDS, respectively (**Appendix WR-5, Table WR-5.6**). Long-term results are similar: **Appendix WR-5, Table WR-5.8** shows similar values for background wells, and **Tables WR-5.9, WR-5.10,** and **WR-5.12** indicate that long-term conditions are similar to recent conditions in the other areas.

Sulfate and TDS conditions along Dinnebito Wash warranted additional review. In the J-21 mine area along Dinnebito Wash, TDS values at WEPO66 and 68 averaged 3,213 mg/L, and sulfate values averaged 1,631 mg/L. The background TDS values in the area ranged from 1,180 to 1,680 mg/L, less than half the average of WEPO66 and 68 near mining. Sulfate concentrations were very low at the background wells in the area, whereas bicarbonate values were much higher. On further review, the TDS and sulfate values differ substantially between WEPO66 and WEPO 68, with much lower concentrations in the latter well approximating background conditions. So the possibility is that mining affects WEPO66, but not WEPO68. Based on Wepo Formation well tests, transit times for potential drainage from the J21 pit to WEPO66 would vary, from over 65 years up to over 800 years (PWCC 2014). Since the pit has been active since 1985 (approximately 32 years), it is unlikely that mining activity has created the elevated sulfate and TDS values in WEPO66. The well is in an undisturbed locale above the influence of alluvial contributions. The most likely source of elevated values in WEPO66 is natural recharge through the porous scoria along Dinnebito Wash, accompanied by drainage through underlying Wepo shales and coal seams.

In addition to the data from wells, Wepo Formation springs that are physically separated from mining activities (e.g., NSPG111, 147) also reflect very high TDS and sulfate concentrations as natural background conditions, as mentioned previously under "*Spring Flow Quality*" in the Affected Environment discussion and tabulated in **Appendix WR-3**. It is likely that natural, near-surface weathering and sediment accumulations from various Wepo Formation lithologies contribute to some of these conditions on upper Black Mesa overall. In particular, weathering of naturally present gypsum in geologic materials contributes to these effects.

Mining activities would expose new chemically reactive particle surfaces during pit excavation and reclamation, when overburden and interburden rocks would be fractured into smaller sizes and mixed. During near-surface wetting and drying, these materials would undergo additional weathering and contribute readily soluble constituents to runoff, seepage, and stored groundwater in mined areas. Based on PWCC information, sufficient carbonate materials and alkaline salts are available in spoil materials to neutralize acid production and drainage resulting from sulfide oxidation (PWCC 2012 et seq.). Consistent with this, very few acid pH results are present in any monitoring data. In this process, where carbonates react to neutralize potentially acid-forming products, additional alkaline salts enter into solution and consequently elevate TDS levels (PWCC 2012 et seq.).

The locations and timing for these effects to appear in deeper water-bearing zones within mine spoils is unknown, and probably varies with site-specific flow gradients, recharge and geologic conditions, and climate patterns. For example, in the N-1 mining area, spoil monitoring wells SPL207 and 209 had median TDS values of 6,100 and 7,805 mg/L, respectively, and median sulfate values of 3,700 and 4,885 mg/L, respectively. In contrast, monitoring well WEPO40 adjacent to the N-1 mine area had typical TDS values of about 1,650 mg/L, and typical sulfate values of about 480 mg/L. While these recent WEPO40 concentrations are greater than typical background values, they are much less than the spoil values. Since the N-1 area was mined and reclaimed between 1974 and 1984, mining effects on groundwater quality in the deeper water-bearing spoil may not materialize. If they ever do, it may take more than a few decades. The extent of groundwater quality impacts, if they occur, would be limited by the complex geologic nature of the Wepo Formation as described in the Affected Environment section and **Appendix WR-5**. The generally isolated nature of Wepo Formation water-bearing zones would prevent effects from occurring much beyond the leasehold. Because of this, impacts to Wepo Formation water quality would be minor under either Proposed Action options. In addition to the other constituents, the vast majority of the Wepo monitoring data for sulfate and TDS remain well within recommended livestock comparison benchmarks. Thus, although water quality effects from mining are anticipated in the Wepo aquifer, they would be comparatively minor impacts. They would have limited extent due to the discontinuous nature of water-bearing zones in the formation (**Appendix WR-5**), and would be limited to separate locations within or adjacent to the leasehold. Further discussions of water quality effects in springs and alluvial groundwater are presented in respective sub-sections below.

3.7.4.2.2.4 Alluvial Aquifers – Water Levels, Water Quality, and Uses

- Scoping Concern: The quantity of groundwater in alluvial deposits could be reduced by mining activities such as pit development, water management, and reclamation. In turn, that may affect existing uses such as livestock watering or riparian habitat.

Impacts from Reduced Alluvial Groundwater Quantities within the Coal Lease Areas from Mining Activities, 3-Unit Operation	Impacts from Reduced Alluvial Groundwater Quantities within the Coal Lease Areas from Mining Activities, 2-Unit Operation
Impacts to water levels or overall groundwater quantities in alluvial deposits would be none or negligible.	Impacts to water levels or overall groundwater quantities in alluvial deposits would be none or negligible.

The greatest water level changes (over 5 feet during the recent period of 2010 through 2014) are recorded in eight wells: ALUV 19, ALUV83, ALUV87, ALUV89R, ALUV98R, ALUV172, ALUV181, and ALUV197 (**Appendix WR-4, Table WR-4.1**). For this recent period, the greatest water level changes occur at ALUV172, which had a maximum rise of 2.0 feet, and a maximum decline of 4.2 feet. The other seven listed wells had water level rises generally between about 1.5 to 3.0 feet, and declines generally between 1.5 to 3.5 feet during the period. Water level changes were smaller in the other 17 alluvial wells with complete annual data in the table. All water level comparisons are based on the deepest recorded levels each year, which is a conservative approach.

Long-term background alluvial wells include ALUV69, ALUV87, and ALUV108R (**Appendix WR-4**, **Figure WR-4.1**). These have data reports through 2014. An earlier background alluvial well (ALUV77) was idled in 2002. Water levels from the 2010 through 2014 period indicate that at these wells, background conditions varied from year-to-year, and changes (rises or declines) were inconsistent between wells. Overall however, depths to water generally increased by 1.3 feet (a water level *decline*) over the period at ALUV69 upstream on Yellow Water Canyon Wash, by 4.4 feet at ALUV87 on the mainstem of Moenkopi Wash, and by 1.1 feet at ALUV108R on Dinnebito Wash. These conditions probably result from drought. Drought conditions are explained more in the climate section (Section 3.2) of the EIS, and previously in Section 3.7.3.1, Regional Overview.

Downstream on Yellow Water Canyon Wash, water levels also generally declined over the 2010-2104 period, similarly to background well ALUV69. Water levels, while generally declining, showed no consistent changes year-to-year or from well-to-well. There were no consistent year-to-year rises or declines associated with the extent of mining activity along the wash. Along Coal Mine Wash over the same period, alluvial water levels fluctuated between rises and declines.

Changes in alluvial water levels along Moenkopi Wash and Dinnebito Wash were similar to those described above for Yellow Water Canyon Wash and Coal Mine Wash. Upstream on Moenkopi Wash, background well ALUV87 had a net water level decline of 4.4 feet over the 2010 through 2014 period. Other wells along the wash generally had rising water levels of about 1 or 2 feet. On Dinnebito Wash, the levels in background well ALUV108R declined a net 1.1 feet; levels in most other wells rose on the order of 0.5 feet.

These overall conditions are consistent with earlier analyses (OSMRE 2011a) that indicated greater declines in alluvial inflows (declining upstream water levels) compared to outflows (downstream rises or mixed fluctuations) across the coal lease areas. Within the coal lease areas, alluvial channels have not deepened to elevations where they intercept the Toreva Formation. Thus, groundwater recharging the alluvium mainly comes from the Wepo Formation (OSMRE 2011a). Other recharge to the alluvium comes from precipitation and infiltration of runoff. The spatial and temporal variations of precipitation, infiltrating runoff, and Wepo Formation contributions create alluvial water levels that vary. Seepage below some impoundments (e.g., J7DAM) prolongs water contributions to alluvial deposits. Water quality aspects of seepage are discussed below. Drought influences all of these factors. Monitoring data indicate that within the coal lease areas, local alluvial water levels may rise or fall during overall declines in background water levels. All of these conditions would continue under either the Proposed Action 3-Unit Operation or 2-Unit Operation.

These results are not likely to affect existing alluvial groundwater uses in the lease area locale. Historically, attempts were made to develop alluvial water resources in the coal lease areas and nearby. However, none of the locations have been utilized or maintained for several decades (OSMRE 2011a). Continued access to potable public water supplies and surface water impoundments make development of the saturated alluvium less attractive for livestock watering or domestic uses. Riparian habitats would continue to be supported by alluvial groundwater as they have been over the past 5 years or more, based on the variability of alluvial water levels and generally smaller declines downstream than in upstream background wells.

Because of these conditions, impacts to alluvial groundwater quantities and availability within and downstream of the coal lease areas would be none or negligible under either Proposed Action option.

- Scoping Concern: The quality of groundwater in alluvial deposits, and its ability to support existing uses such as livestock watering or riparian habitat, could be reduced by mining activities such as pit development, water management, and reclamation.

Impacts from Reduced Alluvial Groundwater Quality within the Coal Lease Areas from Mining Activities, 3-Unit Operation	Impacts from Reduced Alluvial Groundwater Quality within the Coal Lease Areas from Mining Activities, 2-Unit Operation
Trace element impacts would not occur in alluvial groundwater quality. Along with natural background processes, mining would continue to contribute to elevated TDS and sulfate concentrations in alluvial groundwater at some locations. These would be negligible to minor, isolated impacts. No adverse effects to existing water uses are anticipated from continuing variations in alluvial groundwater quality.	Effects would be the same as described for the 3-Unit Operation.

Water quality in alluvial wells has been monitored over time as described in the Affected Environment section and summarized in both recent and long-term tables in **Appendix WR-4**. As previously mentioned (see the alluvial groundwater Affected Environment discussion), it should be noted that surface water quality standards do not apply to groundwater in the alluvium or other aquifers. The wildlife habitat and livestock watering criteria for surface water are simply used here to provide a basis for describing existing conditions in shallower groundwater zones, and as benchmarks for comparing the potential direct, indirect, and cumulative effects of a Proposed Action option or alternatives on water quality. This is consistent with earlier agency approaches (OSMRE 2011b) and recommendations, as well as PWCC annual hydrologic reports. (Drinking water standards are employed for the same purpose for the N-Aquifer.) Therefore, in groundwater discussions, concentrations that are greater than the wildlife habitat or livestock watering criteria are not regulatory exceedances in the same context as surface water evaluations. They are only comparisons to selected reference values.

Aluminum is generally not detected in alluvial groundwater monitoring, either in background or affected locations. When detected, most alluvial groundwater has dissolved aluminum values below the NNEPA total chronic criterion for wildlife habitat (0.087 mg/L); the dissolved fraction is the most biologically available. The selenium criterion for livestock watering (0.05 mg/L) was not surpassed in alluvial groundwater. Where selenium was detected, dissolved concentrations were usually greater than the chronic wildlife habitat criterion (0.002 mg/L). However, this also occurred in upstream background wells ALUV69 and ALVU87, which are unaffected by mining.

Copper and lead were rarely detected in alluvial groundwater monitoring at upstream stations (**Appendix WR-4, Tables WR-4.9** and **WR-4.11**). They also were rarely detected downstream on Moenkopi Wash **Appendix WR-4, Table WR-4.12**) or Dinnebito Wash (**Appendix WR-4, Table WR-4.10**). Lead was detected in 6 percent of downstream samples on Dinnebito Wash, and exceeded standards in one sample out of 64. Vanadium and chromium were rarely detected in alluvial groundwater monitoring at upstream or downstream stations (**Appendix WR-4, Tables WR-4.9** through **WR-4.12**). There were no concentrations in excess of surface water standards for these two constituents. For these four trace elements (copper, lead, vanadium, chromium), these alluvial water quality characteristics would likely continue under either Proposed Action options.

Other trace elements, such as arsenic, cadmium, mercury, and zinc, are either not detected in alluvial groundwater samples or occur at low levels (**Appendix WR-4**). Based on these conditions, no impacts would occur and no existing uses would be affected by trace element constituents by a Proposed Action option.

Sulfate and TDS concentrations also were compared between background conditions and wells likely affected by mining. In background alluvial wells (ALUV69, ALUV87, and ALVU108R), TDS concentrations ranged from 2,880 to 9,900 mg/L during the period 2010 through 2014. Sulfate concentrations also were elevated at all three background wells, ranging between about 1,500 to 6,300 mg/L. As mentioned, these elevated background concentrations reflect alluvial aquifer water quality that has not been affected by mining activity. In comparison to recommended livestock watering concentrations (which are not standards), these background concentrations are elevated (**Appendix WR-4** tables). Because of these levels, TDS and sulfates are the primary constituents used for further alluvial water quality comparisons and impact assessments.

In Yellow Water Canyon Wash and Coal Mine Wash, median alluvial sulfate and TDS concentrations varied between wells, but generally increased notably downstream across the lease areas in both washes. Near the N-1 mine area, nearby alluvial groundwater TDS concentrations at wells ALUV80R and 193 were elevated, with median values of 4,095 and 6,140 mg/L, respectively. Median sulfate values at ALUV80R and 193 also were elevated, at 2,305 and 3,970 mg/L, respectively. In contrast, within the Moenkopi Wash channel alluvium, median concentrations of these constituents declined downstream from high values at ALUV87 upstream of mining. In part, this may be due to the increasing undisturbed watershed area downstream of Reed Valley Wash.

Along Reed Valley Wash, water quality also varied, but recent median TDS and sulfate concentrations generally declined in samples from upstream to downstream. In the Red Peak Valley Wash area, the median sulfate and TDS concentrations in downstream samples at ALUV172 were approximately 2.5 times those of other alluvial wells on upstream tributaries. Elevated concentrations of these constituents also occurred at well ALUV29, most likely a result from J7DAM seepage. Alluvial water quality varied along Dinnebito Wash, where most downstream wells had median TDS and sulfate concentrations similar to background well ALUV87 upstream. As seen in **Appendix WR-4** tables sulfate and TDS concentrations in alluvial groundwater often surpassed recommended concentrations for livestock watering at alluvial monitoring wells near mining. However, these conditions also pertain to background wells. Statistical trends summarized for 16 alluvial wells from 1986 through 2014 (PWCC 2014) indicate that five had no trends for TDS, five had positive (increasing) trends, and six had negative (decreasing) trends). On Dinnebito Wash, background well ALUV108R had an increasing TDS trend, as did ALUV168, which is upstream of most mining activities. For sulfates, four of the 16 wells had no trend, four had increasing trends, and eight had decreasing trends (PWCC 2014). Background well ALUV108R had a decreasing sulfate trend, whereas well ALUV168 had an increasing trend (PWCC 2014). These mixed results are likely to continue under either Proposed Action options.

As noted previously, the Wepo Formation interacts with groundwater in the alluvial aquifer. Springflows and alluvial groundwater may exhibit more rapid geochemical processes at shallower depths, as reflected in background conditions noted at springs NSPG111 and NSPG147 (see the Wepo Aquifer water quality discussion above). Mining effects can locally intensify conditions created by natural background processes, and may have caused increases in some water quality constituents including TDS and sulfate in the leasehold. In addition to transport in baseflows from the Wepo Formation and alluvium, dissolved constituents are left along streams and toeslopes during runoff recessions, along with total constituents deposited with sediments and organic matter. These processes also occur in undisturbed watersheds elsewhere on Black Mesa.

In summary, sulfate and TDS concentrations are elevated in the background alluvial groundwater samples upstream of the mine areas, and along the washes downstream through the lease areas. Along some washes, these concentrations increase downstream through the mine areas; along others, they decrease. Background soil and geologic conditions, mining and water management, seeps and springs, and salt-adapted vegetation affect these variations. A mix of other flow sources (precipitation runoff, mine water management, and Wepo Formation drainage) would continue to influence alluvial water conditions. Because of these factors, negligible to minor, localized groundwater quality impacts are likely to occur at some alluvial aquifer locations within or adjacent to the leasehold. As mentioned previously, PWCC mitigates effects to local water supplies and their uses by developing replacement water supplies. This would avoid impacts to existing water uses during either Proposed Action options.

Since alluvial groundwater is generally not used for livestock watering, that use would not be affected by alluvial groundwater quality. In scattered locations where alluvial groundwater "daylights" to intermittent stream reaches, resulting water quality would periodically reflect some influence of alluvial drainage to the surface. These would be negligible to minor local water quality impacts which would generally not create effects on wildlife habitat uses.

3.7.4.2.2.5 Shallow Springs and Seeps

- Scoping Concern: The occurrence of seeps and springflows from shallow groundwater sources could be reduced in and near the coal leasehold by mining effects on groundwater in the alluvium and Wepo Formation.

Impacts to Flow at Shallow Springs and the Occurrence of Seeps, 3-Unit Operation	Impacts to Flow at Shallow Springs and the Occurrence of Seeps, 2-Unit Operation
Some minor, localized incremental reductions in spring flows and moisture at seeps would likely occur from mining. Minor effects would vary from one locale to another within and adjacent to the leasehold, and would occur within an over-riding trend of declining spring flows in the region due to drought. If the existing drought phase trends back to wetter conditions, springs and seeps would provide more flow or moisture than during recent existing conditions.	Potential impacts would be similar to those described for the 3-Unit Operation.

Shallow springs and seeps are those associated with the Wepo Aquifer and to a lesser degree, channel alluvium. These sources are at or relatively near the land surface, and are further discussed in following sub-sections. Springs and channel baseflows provided by deep groundwater sources were discussed previously, in relation to the N-Aquifer and potential pumping effects from the Proposed Action. Seeps also are associated with sedimentation structures, and their presence depends on runoff captured by the structure. Seeps also may be present naturally.

A number of springs are associated with the Wepo Formation in or near the coal lease areas, as described for the Affected Environment. Long-term flows from approximately 20 monitored springs are summarized in **Appendix WR-3**. Monitored springflows vary substantially over time and from place to place. During the period 2010 through 2014, flows at springs outside of alluvial channel beds either consistently declined, or were within historical ranges until 2014. By 2014, all springflows outside of alluvial channel beds had noticeably declined. This occurred at sites adjacent to mine pits, as well as at background sites separated from mining such as NSPG149 (Sand Spring), NSPG111, and NSPG147.

Changes in alluvial groundwater levels were discussed above. In general, there are recent overall declines in alluvial groundwater levels upstream of the leasehold, within it, and downstream. However, recent flows at springs in alluvial channels, such as NSPG91 in Coal Mine Wash, and others in Red Peak Valley Wash (NSPG561, 562, and 563 in the former Black Mesa Mine area), mimicked their historical flows.

Under either Proposed Action options, some shallow springs and seeps could be affected by surface mining activities such as pit excavations and backfills. There are likely to be continuing declines in springflows near mining under either the 3-Unit Operation or 2-Unit Operation. These effects would vary from one locale to another, depending on climate and recharge as well as local hydraulic gradients and connections. Declines in nearby isolated water-bearing zones in the Wepo Formation and hydraulically connected channel alluvium would result from mine pit development and associated drawdowns. Because of the connectivity to spring features, some incremental springflow reductions near pit activities would likely result from mining. These anticipated flow reductions would occur within an overriding trend of declining springflows at background locations and in the region overall, due to extended drought. Because of these factors and the restricted areas of influence, these would be minor highly localized impacts.

Under both the 3-Unit Operation and 2-Unit Operation, spring flows at NSPG94 and NSPG140 in the N9 coal resource area (**Appendix WR-3, Figure WR-3.1**) would be reduced through drawdown at the proposed mine expansion after 2019. NSPG140 typically has had little or no flow since the early 1980s, but has been known to flow up to 0.1 gpm at one time (**Appendix WR-3, Table WR-3.1**). Existing mining at N9 began in 2007, and it is likely that little or no additional drawdown impacts would occur at NSPG93 and NSPG95. Under the 3-Unit Operation, proposed mining would occur at the N10 coal resource area, approximately 0.7 mile upgradient of NSPG91 and adjacent to NSPG21. Flows could somewhat be reduced there; they ranged from about 0.5 to 1.6 gpm in the past 5 years at NSPG91. Flows at NSPG21 varied from 0 to 5 gpm in 2008, but typically there is no flow. Flows could somewhat be reduced at NSPG22 and NSPG97 near the N11 Extension coal resource area. In the J21-W coal resource area, NSPG191 would be removed by mining. By 2019, it will have already been affected by recent or planned mining there. No subsequent direct impacts to NSPG191 would occur under a Proposed Action option. Because of the factors and conditions described previously, these would be minor, highly localized impacts.

Similar impacts to springs would occur under the 2-Unit Operation, except that anticipated flow reductions at NSPG91 would be unlikely, due to the N10 area being excluded from mining under 2-Unit Operation.

- Scoping Concern: Groundwater quality at shallow springs and seeps could be reduced in and near the leasehold by mining activities.

Impacts to Water Quality at Shallow Springs and Seeps in and Near the Coal Leasehold, 3-Unit Operation	Impacts to Water Quality at Shallow Springs and Seeps in and Near the Coal Leasehold, 2-Unit Operation
Impacts to water quality at shallow-aquifer springs and seeps would be none to minor, and would be highly localized if they occur. An existing formal protocol for seep monitoring and management would continue to avoid or reduce water quality impacts at seeps. Impacts from seeps under this Proposed Action option would be none or negligible.	Potential impacts would be the same as those described for the 3-Unit Operation.

Water quality at most Wepo or alluvial aquifer springs is not anticipated to decline under either Proposed Action options. Springs emanating from reclaimed pit backfills also have been monitored, and are distinguished from natural or native springs (NSPG) by the label indicating a “spoil spring” (SSPG). A limited number of samples taken 5 years apart at SSPG150 indicate TDS and sulfate concentrations there are much less than those at background springs NSPG111, 147, and 92, which are distant from mining. Based on data, reclaimed pit backfills are not anticipated to adversely affect spring water quality.

At other monitored springs that could be affected by proposed mining activities, some already reflect elevated sulfate and TDS concentrations on the order of those at background locations such as NSPG111. These monitored springs include NSPG22 and NSPG140. Their water quality would not be affected by proposed mining. In addition, NSPG91 and NSPG191 have existing water quality similar to Wepo Formation groundwater in wells that are likely affected by mining. NSPG21 has water quality similar to Wepo wells believed not to be affected by mining. Water quality at these last three springs (NSPG91, 191, and 21) may be further reduced by proposed mining. In the recent past, NSPG91 has typically flowed, but NSPG21 and 191 typically have not been flowing. Historical average flows have been 0.55 to 3.11 gpm at the three sites. Because of their proximity to proposed mining, it is likely that negligible to minor localized water quality effects would occur at these three locations. For existing uses, permanent ponds would mitigate water quality impacts and provide more reliable water supply.

The occurrence of seeps, and formal plans to address impacts related to seeps, was described in the Affected Environment section. Additional seeps are likely to occur downstream of ponds and impoundments as these are built during either Proposed Action options. Other seeps would be removed as mining and reclamation proceed. Highly localized impacts to adjacent surface water quality may occur under either Proposed Action options. Since the USEPA and PWCC have instituted a formal seep monitoring and management plan, and an associated review protocol, those impacts that may occur at seeps would be identified and mitigated. As a result, future impacts to surface water quality at seeps would be none to negligible under either Proposed Action options.

3.7.4.2.2.6 Moenkopi and Dinnebito Washes, Streams

- Scoping Concern: Streamflows and related designated uses downstream along Moenkopi Wash or Dinnebito Wash could be reduced by water retained in additional ponds and impoundments at the proposed KMC.

Impacts from Additional Ponds or Impoundments at the Proposed KMC, 3-Unit Operation	Impacts from Additional Ponds or Impoundments at the Proposed KMC, 2-Unit Operation
Along Moenkopi Wash or Dinnebito Wash in and near the leasehold itself, during mining there would be moderate hydrologic shifts from estimated average channel flows being withheld as retention storage. These effects would decline after reclamation at the end of proposed mining. In addition, permanent ponds would mitigate impacts to existing designated water uses and improve local water availability near the mine area. Existing channel seepage losses, evapotranspiration, storm variability, and the ephemeral nature of flows prevent potential storage effects on the leasehold from extending far downstream.	Impacts would be similar to the 3-Unit Operation.

Temporary sediment ponds are important structures that help control runoff and surface water quality in the leasehold and nearby downstream channels. Along with other structures and management practices, they are designed, constructed, maintained, and reclaimed as needed to comply with regulatory programs. Surface water quantities would be affected in the coal leasehold by the increased extent of disturbed areas, and by the drainage and retention structures employed to manage runoff, sediment, and pit inflows. Greater runoff volumes, higher discharges during storms, and increased sediment yields would result from project components such as roads, storage yards, and the areas undergoing mining and reclamation. These potential impacts have long been recognized in regulatory programs and corresponding mine water management. In response, PWCC has designed, constructed, and maintained the surface water management system at former and existing facilities, and would do so for the proposed KMC. As noted in Chapter 1.0 (where existing and proposed facilities at the proposed KMC are described), the status and numbers of ponds and impoundments would change during the proposed Life-of-Mine. These changes are reflected in **Table 3.7-21** below. The locations and characteristics of permanent ponds and impoundments are determined through coordination with applicable agencies.

Table 3.7-21 Status and Numbers of Ponds and Impoundments, Proposed KMC

Pond or Impoundment Type	Anticipated Inventory, 2019	Anticipated Inventory, Life-of-Mine
Permanent	50	51
Temporary	115	142
Reclaimed	101	243

Source: PWCC 2016.

Also as described in Chapter 1.0, major structural practices that control runoff and its quality include temporary and permanent ponds, larger impoundments, stream diversions, and ditches and road drainage systems. On reclaimed lands, re-establishment of vegetative cover helps control overland flow, and benches along the slope contours control drainage on lands with OSMRE Permanent Program jurisdiction. Geomorphic reclamation is being conducted to promote more naturally functioning drainage. Structural practices in concentrated flow areas, such as rock-reinforced down-drains, check dams, and retention structures, reduce sediment yield and runoff from disturbed areas and minimize their off-site impacts. While they control accelerated runoff, erosion, and sediment yield, these structural practices also reduce surface water yields from the headwaters of the major drainages.

At the downstream edge of the leasehold, Moenkopi Wash at the PWCC monitoring locations has a watershed area of about 253 square miles. Similarly, Dinnebito Wash at the edge of the leasehold has a drainage area of about 51 square miles (OSMRE 2011a). This creates a combined drainage area of about 304 square miles at the downstream PWCC monitoring points for the leasehold.

As of June 2008, the Moenkopi Wash basin area impounded for water quality management within the leasehold was approximately 66 square miles. This is about 26 percent of basin area for Moenkopi Wash at the downstream edge of the leasehold (PWCC 2012 et seq.). The area planned to be impounded during 2013 was about 70 square miles (PWCC 2012 et seq.). Based on this recent disturbance estimate, it is projected that about 74.5 square miles of Moenkopi Wash basin area within the leasehold would be controlled by ponds and impoundments by the end of 2019. With this assumption, approximately 29.4 percent of the drainage area within the leasehold would be affected by retention of runoff and baseflow in ponds or impoundments at that time. Successful reclamation and pond removals would reduce that extent by increasing the area of free-draining landscapes. For EIS purposes, it is assumed that flow from 74.5 square miles (29.4 percent) of the Moenkopi Wash drainage area at the downstream edge of the leasehold would be subject to retention in the mine water management system at the start of either the 3-Unit Operation or 2-Unit Operation. Using a similar approach based on recent disturbance estimates, flow from a projected 6.9 square miles (13.5 percent) of the Dinnebito Wash basin area at the downstream edge of the leasehold would be subject to retention for water quality management at the end of 2019.

Based on 22 years of recordkeeping, PWCC has estimated that the average annual runoff is about 0.15 inch per year at the downstream leasehold monitoring stations on Moenkopi Wash (**Appendix WR-1, Figure WR-1.1**). Using that estimate, and assuming it applies to Dinnebito Wash as well, the average annual runoff from the overall 304 square miles leasehold drainage area without any retention would be approximately 2,432 acre-feet per year. Estimated magnitudes of runoff retained in 2019 for PWCC water quality management practices are projected in **Table 3.7-22**.

Note that these are general estimates made for purposes of comparison; actual retention would vary according to highly variable storms and annual conditions, as well as changes in actual pond numbers, volumes managed, and reclamation.

With implementation of the 3-Unit Operation, additional mining and accompanying water controls would occur in the N9, N10, N11 Extension, J19, and J21-W, coal resource areas (see Chapter 1.0). Activities in the J19 area and most of the J21 and N9 areas would occur within an existing controlled drainage. The remaining expansions would restrict additional runoff from approximately 10.5 square miles of additional watershed areas, mostly in the N11 Extension area. This value is approximate, and assumes that runoff from upgradient watershed areas would be routed into downslope retention structures. Under the 2-Unit Operation, the N10 coal resource area would not be mined. This area and a small upgradient watershed occupy roughly 2.1 square miles, assuming the drainages to the east would not be affected.

Table 3.7-22 Projected Runoff Effects of Structural Management Practices, 2019 Background

Local Drainage Basin (in and Above Leasehold)	Overall Area (square miles)	Projected Retained Area (square miles)	Projected Percent of Area Retained	Estimated Runoff Volume without Practices (acre-feet per year)	Projected Retained Runoff Volume (acre-feet per year)	Projected Percent of Local Runoff Retained
Moenkopi Wash	253	74.5	29.4	2,024	596.0	29.4
Dinnebito Wash	51	6.9	13.5	408	55.2	13.5
Total	304	81.4	26.8	2,432	651.2	26.8

Using a similar approach to runoff estimates as used for **Table 3.7-22** above, summaries of potential reductions in the calculated background mean annual runoff volume are presented in **Tables 3.7-23** and **3.7-24** for the 3-Unit Operation and 2-Unit Operation, respectively. As footnoted for the tables below, these estimates are for comparison purposes only, and are based on long-term averages and other assumptions. The actual unrestricted runoff volumes, and the retained or discharged volumes, would vary from year-to-year according to precipitation and evaporation conditions, pond construction or reclamation, and pond releases.

Table 3.7-23 Estimated Average Annual Leasehold Runoff Modifications at the End of Mining, 3-Unit Operation

Local Drainage Basin (in and above Leasehold)[1, 2]	Overall Area (square miles)	Projected Retained Area (square miles)	Projected Percent of Area Retained	Projected Retained Runoff Volume (acre-feet per year)	Projected Retention Increase from 2019[3] (acre-feet per year)	Increase in Percent Local Retention from 2019
Moenkopi Wash	253	84.0	33.2	672.0	76.0	12.8
Dinnebito Wash	51	7.9	15.5	63.2	8.2	14.8
Total	304	101.1	33.3	735.2	84.2	12.9

[1] All values are estimates developed for purposes of comparison only, and assume no discharges from ponds or impoundments, or removal of ponds and impoundments after successful reclamation. Actual values would vary according to annual precipitation, extent of disturbance, and the status of ponds and impoundments.

[2] Estimates are for the areas of the Moenkopi Wash and Dinnebito Wash drainages near the downstream boundaries of the leasehold (PWCC monitoring Stations SW25 and SW34).

[3] Basis of comparison is Projected Retained Runoff Volume in 2019 background, **Table 3.7-22**.

Table 3.7-24 Estimated Average Annual Leasehold Runoff Modifications at the End of Mining, 2-Unit Operation

Local Drainage Basin (in and above Leasehold)[1, 2]	Overall Area (square miles)	Projected Retained Area (square miles)	Projected Percent of Area Retained	Projected Retained Runoff Volume (acre-feet per year)	Projected Retention Increase from 2019[3] (acre-feet per year)	Increase in Percent Local Retention from 2019
Moenkopi Wash	253	81.9	32.4	655.2	59.2	9.9
Dinnebito Wash	51	7.9	15.5	63.2	8.2	14.8
Total	304	89.8	29.5	718.4	67.4	10.3

[1] All values are estimates developed for purposes of comparison only, and assume no discharges from ponds or impoundments, or removal of ponds and impoundments after successful reclamation. Actual values would vary according to annual precipitation, extent of disturbance, and the status of ponds and impoundments.

[2] Estimates are for the areas of the Moenkopi Wash and Dinnebito Wash drainages near the downstream boundaries of the leasehold (PWCC monitoring Stations SW25 and SW34).

[3] Basis of comparison is Projected Retained Runoff Volume in 2019 background, **Table 3.7-22**.

From estimates depicted in **Table 3.7-23**, without releases or pond removals, the 3-Unit Operation could retain approximately 12.9 percent more runoff in the leasehold at the end of mining than was estimated for 2019. This would be a minor to moderate hydrologic impact during the active mining timeframe. After reclamation, there would be a net decline of about 6.6 percent from estimated 2019 conditions (26.8 in **Table 3.7-22** minus 20.2 in **Table 3.7-25**). As a comparative estimate, about 20 percent of runoff (**Table 3.7-25**) would be retained as water supply in ponds and impoundments after reclamation, a moderate hydrologic impact.

Table 3.7-25 Estimated Average Annual Leasehold Runoff Modifications after Post-mining Reclamation, 3-Unit Operation and 2-Unit Operation

Local Drainage Basin (in and above Leasehold)[1, 2]	Overall Area (square miles)	Projected Retained Area (square miles)	Projected Percent of Area Retained	Estimated Runoff Volume without Practices (acre-feet per year)	Projected Retained Runoff Volume (acre-feet per year)	Projected Percent of Local Basin Runoff Retained
Moenkopi Wash	253	57.5	22.7	2,024	460.0	22.7
Dinnebito Wash	51	3.8	7.5	408	30.4	7.5
Total	304	61.3	20.2	2,432	490.4	20.2

[1] All values are estimates developed for purposes of comparison only, and assume no discharges from ponds or impoundments, or removal of permanent post-mining ponds and impoundments. Actual values would vary according to annual precipitation, extent of disturbance, and operations of permanent ponds and impoundments.

[2] Estimates are for the areas of the Moenkopi Wash and Dinnebito Wash drainages near the downstream boundaries of the leasehold (PWCC monitoring Stations SW25 and SW34).

Source: Some information is derived from PWCC 2012 et seq.

From estimates depicted in **Table 3.7-24**, without releases or pond removals, the 2-Unit Operation could retain approximately 10.3 percent more runoff in the leasehold at the end of mining than was estimated for 2019. Similar to the 3-Unit Operation, after reclamation there would be a net decline of about 6.6 percent from estimated 2019 conditions (26.8 in **Table 3.7-22** minus 20.2 in **Table 3.7-25**). Similarly, as a comparative estimate about 20 percent of runoff would be retained under the 2-Unit Operation as water supply in ponds and impoundments after reclamation. Hydrologically, these would be moderate impacts.

The 3-Unit Operation would retain, as a comparative estimate, about 17 acre-feet per year more in the Moenkopi Wash drainage than the 2-Unit Operation. The effects of storage in the Dinnebito Wash drainage would be similar between the two Proposed Action options. At the end of mining and reclamation for either Proposed Action options, some contributing watershed areas would be restored as noted. Other runoff would be managed for local livestock watering and aquatic and wildlife habitat by permanent post-mining impoundments. This is part of existing agreements and approved post-mining land use objectives. Permanent post-mining impoundments could affect long-term runoff at the downstream edges of the leasehold as estimated in **Table 3.7-25**. Actual retention may vary.

Impacts to support of existing designated uses, as separately defined and established by the Navajo Nation and the Hopi Tribe in their respective surface water quality standards, would differ from the hydrologic impacts described above. Existing designated uses of surface water on and near the leasehold are restricted to wildlife and aquatic uses, occasional opportunistic livestock watering, and possibly limited opportunistic human contact such as wading or washing. These use categories are designated in the separate tribal water quality standards established by the Navajo Nation and the Hopi Tribe (**Appendix WR-1**). No irrigated agriculture or other uses exist on or near the leasehold. Although the additional retention of runoff at the proposed KMC would somewhat reduce average surface water flows in Moenkopi Wash and Dinnebito Wash in and near the leasehold, overall impacts to these uses would be negligible from either the 3-Unit Operation or 2-Unit Operation. Again, the table values are general estimates made for purposes of comparison; actual retention would vary according to highly variable storm conditions and pond releases. First of all, average conditions do not reflect that actual flow durations in the upper washes are ephemeral (or isolated intermittent); much of the time there is no water in the channels. In addition, discharges from ponds and impoundments do occur under suitable conditions, and may provide flows when streams may otherwise be dry. Due to evapotranspiration, the ephemeral nature of streamflows, and substantial seepage losses to the alluvium en route, background conditions allow little or no streamflow from the leasehold to contribute to distant downstream flows. Distant downstream Impacts from mine-related retention are none to negligible.

While there would be a hydrologic shift from channel flows to pond retention, the reason the overall impacts to water uses would be negligible is that a sizeable portion (e.g., half) of ponds and impoundments are open to livestock watering and wildlife. This provides additional grazing and habitat uses in the headwaters, and improves the availability of water compared to the ephemeral or limited intermittent channel reaches there. Permanent structures would provide these beneficial effects locally on Black Mesa during either Proposed Action options. Permanent impoundment uses also would remain as local beneficial effects after reclamation, in accordance with the existing mine plan and lease agreements.

Within or near the leasehold, riparian zones in the Moenkopi Wash watershed are most extensive along Coal Mine Wash, along Moenkopi Wash itself south and west of Navajo Route 41, and at the confluence of Moenkopi Wash and Red Peak Valley Wash. All of these areas are within the leasehold and do not appear to be adversely affected by past mine water management. They may be supported in part by releases from upstream ponds and impoundments, and by seepage from those facilities.

Another riparian zone starts about 1.5 miles below the confluence of Coal Mine Wash with Moenkopi Wash, and extends downstream for about another 3 miles. Its greatest width is within the upper 1.5 miles. Downstream of that, a narrower belt of riparian vegetation occurs along the channel. This zone is the only extensive, downstream riparian expression near the leasehold. It occurs in an eroded basin where the Mancos Shale is exposed at the land surface. The less permeable nature of the shale forces alluvial groundwater to remain near the surface. In combination with inflows and local shale runoff, this supports the riparian zone downstream until evapotranspiration and channel migration limit the further extent of riparian conditions.

Under a Proposed Action option, effects from reduced average runoff could occur at this nearby riparian area. Impacts could be too subtle to be detectable, however. The runoff reductions estimated above are fairly limited. Actual water reductions are likely to be limited as well, for the reasons noted above. Further, the extent of riparian habitat varies with multi-year precipitation conditions, and also as Moenkopi Wash migrates within its floodplain and terrace system. These factors would make impacts indistinguishable from ongoing natural processes. Because of these factors, retained storage impacts to riparian areas in or near the leasehold would be none to negligible.

- Scoping Concern: Reduced surface water quality from mining activities and discharges from the proposed KMC could adversely impact designated uses downstream along Moenkopi Wash or Dinnebito Wash.

Surface Water Quality Impacts from Activities or Discharges at the Proposed KMC, 3-Unit Operation	Surface Water Quality Impacts from Activities or Discharges at the Proposed KMC, 2-Unit Operation
Stream water quality would continue to be influenced mainly by background conditions. Trace element impacts would not occur or would be negligible. Sediment controls would restrict erosion and sedimentation impacts to negligible levels during mining, and reclaimed sediment yields would mimic undisturbed conditions. Minor localized impacts from TDS and sulfate concentrations would occur.	Potential impacts would be the same as described for the 3-Unit Operation.

Surface water quality could be adversely affected by either Proposed Action options. Runoff would carry sediment and other constituents from roads, active mine areas, reclamation in progress, coal processing areas, and storage yards. This would continue through the life-of-mine. Runoff would be collected in temporary or permanent sediment ponds and impoundments. As described in the Affected Environment section, numerous retention structures have been constructed in accordance with, or in excess of, regulatory requirements. The number and locations of these features would change as mining and reclamation proceed.

Currently, impounded water at the proposed KMC is retained indefinitely and pumped between ponds as needed, according to pool volumes and available storage capacities. Much of the retained volume evaporates, and a lesser amount seeps from some of the ponds. Discharges are pumped from selected ponds when sufficient volume and water quality have been attained through mixing and settlement. Receiving waters are Moenkopi Wash or Dinnebito Wash, either directly or through their tributaries. Existing USEPA NPDES permit provisions and associated monitoring form compliance goals for these activities. These approaches to runoff and sediment management would continue with either Proposed Action options.

As described previously, recent (2010 through 2014) data have been employed to describe current existing conditions at the mine. Although mining continues to modify watersheds, no recent surface water data are available upstream of the mine. In the available surface water data for 2010 through 2014, occasional exceedances of tribal standards occur for total recoverable trace elements including aluminum, arsenic, cadmium, copper, lead, mercury, and vanadium. Most of the time, however, trace element concentrations in recent surface water samples are below laboratory detection limits (**Appendix WR-1**). When they are above detectable levels, these several constituents are somewhat consistent in exceeding standards for listed designated uses. Most involve total recoverable concentrations (no TSS filtered from the sample), whereas their dissolved concentrations (TSS filtered from the sample prior to analysis) rarely exceed standards. The most restrictive standards and/or common standards exceedances for these constituents are summarized below. It should be noted that standards and their corresponding criteria vary between the Navajo Nation and the Hopi Tribe (**Appendix WR-1**).

- Total aluminum, chronic, for aquatic and wildlife habitat;
- Total arsenic, for fish consumption or full body contact;
- Total cadmium, for fish consumption;
- Total copper, for livestock watering;
- Total lead, for full body or secondary human contact and livestock watering;
- Total mercury, chronic, for aquatic and wildlife habitat;
- Total selenium, chronic, for aquatic and wildlife habitat;
- TSS for aquatic and wildlife habitat; and
- Where Hopi tribal water quality standards apply, total iron, TDS, sulfate, and total vanadium concentrations also commonly exceed criteria.

Fish consumption or full body contact are probably not common or regular uses of upper Moenkopi Wash, upper Dinnebito Wash, or any of their tributaries within or near the leasehold. Further discussions of ecological and human health risks related to water quality are presented in Sections 3.0.3 (Ecological and Human Health Risk Assessment Approach), 3.10.2 (Terrestrial Wildlife Resources), and 3.12.2 (Aquatic Biological Resources). Additional risk assessment details are presented in **Appendix 3RA**. Studies conducted for the ERA at the mine indicate that total arsenic and cadmium do not pose unacceptable risks in streams (Ramboll Environ 2016d). Therefore, related arsenic and cadmium exceedances are not considered further. The chronic aluminum and mercury criteria (respectively, 0.087 mg/L and 0.001 µg/L) for aquatic and wildlife habitat are so low that, given background sources, they are likely to be exceeded in local or regional streamflows whether PWCC mining activity is present or not.

Further, aluminum was not detected in 25 percent of recent samples on lower Moenkopi Wash (Site SW26). Mercury was not detected in 38 percent of samples there.

An examination of long-term data (**Appendix WR-1, Tables WR-1.17** through **WR-1.20**) indicates that both total and dissolved iron concentrations typically declined on Moenkopi Wash from upstream of the mine to the downstream limit of the leasehold. On Dinnebito Wash, long-term (1985 through 2005) average total iron concentrations increased somewhat from upstream to downstream, but the median values declined from upstream to downstream. Importantly, dissolved iron concentrations were low on both washes over the long term in a slightly alkaline setting. Because of these data results and considerations, impacts from these five constituents (aluminum, arsenic, cadmium, iron, and mercury) due to mining activities under a Proposed Action option would not occur.

Of the remaining constituents listed above, copper and lead could adversely affect livestock watering under either Proposed Action options. Selenium and TSS could adversely affect habitat uses under either Proposed Action options. However, copper was not detected in 50 percent of recent samples on downstream Moenkopi Wash (Site SW26); lead was not detected in 50 percent of recent samples there, and selenium was not detected in 56 percent of samples there (**Appendix WR-1, Table WR-1.11**). Recent data for Dinnebito Wash (**Appendix WR-1, Tables WR-1.15** and **WR-1.16**) indicate elevated concentrations of total copper, total lead, and total selenium in comparison to standards. These data reflect only storm runoff conditions, with TSS concentrations much greater than those in Moenkopi Wash samples representing both runoff and baseflow. The storm sediment load affects those results on Dinnebito Wash, where much of the watershed is undisturbed and contributes to water quality conditions.

Recent (2010 through 2014) total vanadium and total chromium concentrations also are typically elevated in runoff from Moenkopi Wash and Dinnebito Wash, in samples where they are detected. However, these constituents are not detected in many monitoring samples (**Appendix WR-1** tables), particularly in dissolved forms represented by longer-term data. For example, neither dissolved chromium nor dissolved vanadium were ever detected in long-term (1985 through 2005) downstream samples at Station CG34 on Dinnebito Wash (**Appendix WR-1, Table WR-1.20**). Criteria are not listed for total vanadium on Navajo Nation lands, and average or median total chromium concentrations approximate the livestock criteria at lower Coal Mine Wash, Red Peak Valley Wash, and lower Dinnebito Wash (**Appendix WR-1, Tables WR-1.8**, **WR-1.13**, and **WR-1.16**, respectively).

The recent results indicate that if total concentrations of chromium, copper, lead, selenium, and vanadium are: 1) sufficiently present to be detectable; and 2) biologically available, they could reduce surface water quality for habitat uses or livestock watering within and near the coal lease areas over time. It should be noted that these total constituents are not detected in all recent samples, however, particularly in the Moenkopi Wash drainages. In addition, both recent and long-term dissolved concentrations of these constituents are typically well below standards for habitat and livestock watering, and the dissolved fraction is usually the most biologically available. Therefore, over the planned life of the Proposed Action and later, overall mining effects on designated uses from trace elements in surface flows would probably be undetectable.

TSS concentrations typically exceed applicable water quality standard both upstream and downstream of mining activities. TSS values in lower Coal Mine Wash (Site SW25) are lower than stations over on the Moenkopi Wash mainstem. In combined Moenkopi Wash drainages, long-term data indicate that average TSS concentrations declined by about 21 percent from upstream to downstream (**Appendix WR-1, Tables WR-1.17** and **WR-1.18**, respectively). The median concentrations were similar from upstream to downstream. These outcomes likely result from the extensive erosion and sedimentation controls within the Moenkopi Wash drainages. Along Dinnebito Wash, available long-term data indicate that typical TSS concentrations increased by about 40 to 50 percent from upstream to downstream (**Appendix WR-1, Tables WR-1.19** and **WR-1.20**, respectively). Large parts of the Dinnebito Wash drainage remain undisturbed and un-managed by structural practices. In arid areas, it is not unusual for TSS concentrations to increase in downstream flows, due to naturally erosive landscapes and re-mobilized channel storage or bank erosion. These are significant contributors to sediment supply and transport throughout the project region. In addition, TSS concentrations can vary widely with localized, short-term storm conditions. The existing conditions and management applications would continue in the Moenkopi Wash drainages and along Dinnebito Wash under either Proposed Action options.

Based on recent and historical data, TSS concentrations from disturbed areas are well controlled by mine water management, In addition, OSMRE conducts quarterly inspections of reclamation, water conveyance structures and sediment ponds at the Kayenta Mine, and semi-annual inspections of all areas at the inactive former Black Mesa Mine area. PWCC also conducts ongoing inspections to meet permit conditions. Both protocols include remedial actions and monitoring if problems are encountered. Because of all these factors, no detectable TSS impacts would occur during a Proposed Action option.

Runoff, erosion, and sediment transport within the coal leaseholds were intensively monitored by PWCC at stream monitoring stations established along the larger channels and within small watersheds during a long-term field study (PWCC 2012 et seq.). These involved comparisons of disturbed and undisturbed conditions, stream channel monitoring, and runoff and erosion plots. Based on all of the various study results and corresponding modeling efforts, retention structures and other drainage control features have been designed and constructed by PWCC in accordance with water quality OSMRE guidelines, design requirements, NPDES permit stipulations, and reclamation objectives. The SEDIMOT II/SEDCAD model and/or EASI model were used as design tools (PWCC 2012 et seq.) or to evaluate spoil grading plans and overall watershed characteristics during reclamation planning. Modeling inputs and reviews were tailored to the field study results, and outputs compared well to actual conditions for undisturbed, active, and reclaimed areas.

In addition to managing runoff, erosion, and sediment during proposed active mining, these efforts are useful for projecting long-term future conditions during and after proposed reclamation. To compare pre-mining and post-mining conditions, both the SEDIMOT II/SEDCAD and EASI models were employed by PWCC. Initial historical work used the former approach, and more rigorous work subsequently used the EASI model (PWCC 2012 et seq.). Both efforts indicated that average annual sediment yield after successful reclamation would be equal to or less than pre-mining conditions. This is anticipated to be a local effect of reclamation and stabilization practices. Notably, on broader watershed scales both within and beyond the coal leasehold, natural background sediment contributions will continue to affect Moenkopi and Dinnebito washes with or without a Proposed Action option. While some material will originate from hillslopes, more substantial sediment dynamics (erosion, sediment storage and transport) will naturally result from existing lateral inflows and channel bed-and-bank conditions downstream of mining activities along the major washes, These processes will be similar to current background conditions in the region, such as along lower Moenkopi and Dinnebito washes, Polacca Wash, or Jeddito Wash. In addition, sediment yields and other water quality characteristics vary substantially with localized runoff conditions.

After proposed mining, reclamation would involve recontouring and terracing with geomorphic considerations to restore stable hillslopes and drainages. Revegetation, removal of temporary sediment ponds, and implementation of alternative sediment control measures would support long-term stabilization and post-mining land uses (PWCC 2012 et seq.). PWCC conducted rigorous EASI runoff and sediment yield modeling, with results that compared well to monitoring program results. Based on post-mining projections stemming from that effort, sediment ponds could be removed and reclaimed, and best management practices would successfully control sediment yields to less than or equal to the average annual sediment yield from pre-mining watersheds. In addition to the post-mining projections, post-reclamation monitoring is required by OSMRE to demonstrate the success of reclamation practices. With this long-term control of sediment yield from mining disturbance, TSS concentrations after reclamation would likely be similar to or less than those from disturbed conditions.

Because of these factors, no long-term post-mining impacts from erosion or sediment yield would occur from a Proposed Action option.

Recent (2010 through 2014) PWCC surface water data generally indicate elevated concentrations of TDS and sulfate across the leasehold. Some of this is due to natural background conditions, as documented upstream of the mine from both stream and native spring monitoring and long-term data. Baseflow concentrations sometimes exceed recommended livestock watering values for sulfate (1,000 mg/L); and TDS (3,000 mg/L) (Raisbeck et al. 2008; Sigler and Kleehammer 2013). Concentrations are typically much less during runoff. Hopi tribal water quality standards for aquatic and wildlife habitats are consistently exceeded at downstream monitoring sites, but again, natural background conditions contribute to this based on long-term data.

Recent (2010 through 2014) data for Dinnebito Wash indicate that TDS and sulfate values are relatively low at the leasehold boundary (median values of 370 mg/L and 158 mg/L, respectively, at Site SW34). They increase further downstream at location CG34. In contrast, long-term (1985 through 2005) data show that background values of both TDS and sulfate are greater on Dinnebito Wash upstream of the mine than downstream (**Appendix WR-1, Tables WR-1.19** and **WR-1.20**). The contrast is due to flow conditions at the time of sampling, and the number of samples. Recent data (**Appendix WR-1, Tables WR-1.15** and **WR-1.16**) are comprised of storm runoff only, from eight samples upstream at SW34 and six samples downstream at CG34. At both stations, recent data reflect several samples taken during a single day or runoff event. There is substantial recent water quality variation due to the timing of sampling with respect to phases of the storm runoff hydrograph. In the long-term data set, these factors have less influence. The long-term data indicate that upstream inflows have greater TDS and sulfate concentrations as a natural background condition, and that typical values decline downstream (**Appendix WR-1, Tables WR-1.19** and **WR-1.20**).

Recent (2010 through 2014) TDS and sulfate concentrations on Moenkopi Wash are typically elevated, largely due to baseflow concentrations. Average and median long-term data (1981 through 2008) are substantially less, and typically both upstream and downstream long-term conditions are well within water quality guideline values. Typical long-term (1981 through 2008) background values of both TDS and sulfate are greater downstream of the mine on Moenkopi Wash (**Appendix WR-1, Tables WR-1.17** and **WR-1.18**).

Overall, it is likely that some of the sulfate and TDS concentrations occur naturally, and some increases may result from mining effects. This is based on older historical data and native spring samples indicating that high concentrations exist upgradient of the mine (for example, see **Appendix WR-3, Table WR-3.1**), These conditions are likely to continue through the planned life-of-project and beyond, under either Proposed Action options. As a result, occasional concentrations of TDS and sulfate are likely to be greater than habitat standards or unofficial livestock watering guidelines. Because of the background contributions, and the likelihood of local adaptations to water quality by local livestock or wildlife, these would be minor localized impacts. Both upstream and downstream of the leasehold, water quality would continue to be influenced by highly localized precipitation conditions and geologic sources of these constituents. Impacts to distant downstream surface water quality would be none to negligible.

3.7.4.2.2.7 Ponds and Impoundments

- Scoping Concern: Ponds and Impoundments at the proposed KMC might not be adequately built or maintained to control runoff and provide supplemental water supplies. Water quality in ponds and impoundments may not be suitable for existing designated uses.

Impacts from Pond and Impoundment Characteristics at the Proposed KMC, 3-Unit Operation	Impacts from Pond and Impoundment Characteristics at the Proposed KMC, 2-Unit Operation
Retention structures would be designed, constructed, and maintained to meet or exceed applicable agency requirements. No impacts would occur related to this consideration. Moderate temporary exceedances of habitat selenium standards or recommended sulfate and/or TDS guidelines may occur in some temporary ponds in the northern area of the leasehold. Long-term water quality in permanent ponds and impoundments would support existing designated uses without impacts.	Potential impacts would be similar to those described for the 3-Unit Operation, but there would be minor or no impacts from selenium, sulfate, or TDS in northern area temporary ponds.

Over the life of either Proposed Action options, the locations of ponds and impoundments would change as mining and reclamation proceed. Sediment ponds would be created to serve new mining activities, and others would be removed after successful reclamation. The timing of these changes is somewhat unknown, since pond locations and designs would depend on selection of a project alternative. In any case, these structures would be designed, constructed, inspected and maintained in accordance with, or in excess of, applicable OSMRE and Mine Safety and Health Administration regulatory requirements. This would be consistent with existing PWCC practices within the coal leasehold. The potential effects of ponds and impoundments on surface flows and runoff are discussed above.

Pond water quality data reflect areas and activities similar to what would be involved in either Proposed Action options. Suspended solids concentrations were low in all retained water. Trace element concentrations were generally low, and often were below detection limits (**Appendix WR-2, Tables WR-2.2** and **WR-2.3**). Typical total selenium concentrations, when detected, exceeded aquatic and wildlife habitat criteria. However, total selenium was only detected in 15 percent of samples (one out of seven) from the J16-J21-J28 part of the leasehold, and in 50 percent of samples (6 out of 12) from the N2 through N11 part. Sulfate and TDS concentrations were generally low in retained water in the southeastern part of the leasehold (J coal resource areas). These constituent concentrations were considerably higher in samples from existing ponds in the northwestern part of the leasehold along Coal Mine Wash (“N” coal resource areas as depicted in **Appendix WR-2, Figure WR-2.1**, and chemical data reported in **Appendix WR-2, Table WR-2.3**). Livestock watering and aquatic and wildlife habitat uses would be temporarily impacted by TDS and sulfate concentrations in some ponds associated with the N coal resource areas.

In the northern part of the leasehold, effects to water uses would likely occur from additional sources of selenium, sulfate and TDS at some temporary sediment ponds. Further review of pond water quality data from the N10-N11 area along Coal Mine Wash indicates a median TDS value of 2,825 mg/L, and a median sulfate concentration of 1,720 mg/L. Based on this information, there may be moderate temporary impacts during mining activities to livestock watering and aquatic and wildlife designated uses in the N10-N11 coal resource areas. Since these temporary ponds are used only for sediment and storm water retention, other uses would be incidental. Other ponds nearby would provide water for livestock watering and habitat uses. Impacts would be less (negligible or minor) under the 2-Unit Operation, since the N10 area would not be mined in that option. No impacts to pond or impoundment water quality are anticipated in the southern part of the leasehold, under either temporary or permanent conditions. Generally, retained water there is well-suited for livestock watering and aquatic and wildlife uses.

Both north- and south-area permanent ponds generally have much lower median concentrations, with an overall TDS value of 1,260 mg/L and a sulfate value of 710 mg/L in the north based on recent sampling. So over the long term, post-mining pond water quality on the reclaimed areas would be adequate for aquatic and wildlife uses and livestock watering.

In compliance with Surface Mining Control and Reclamation Act regulations and the OSMRE-approved permit, most ponds would be removed and their locations reclaimed as mining progresses, Permanent ponds and impoundments would remain as agreed upon with tribal authorities and OSMRE permit approvals. The persistence of water in permanent ponds is satisfactorily addressed in the Permit Application Package. Its long-term suitability for common uses is demonstrated in monitoring data and annual reports submitted to OSMRE. It is assumed for purposes of this EIS that tribal authorities would conduct due diligence assessments of conditions at permanent ponds and impoundments prior to transfer of ownership from PWCC. It also is assumed that any sediment quality issues or other considerations related to pond or impoundment conditions would be resolved as needed between tribal authorities and PWCC prior to ownership transfers.

3.7.4.2.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

Numerous ephemeral and intermittent streams are crossed by the transmission line alignments. The following streams have perennial flow segments within the transmission line ROWs:

- WTS – Colorado River, Paria River, Muddy River, Virgin River, Las Vegas Wash, and Meadow Valley Wash.
- STS – Agua Fria River, Big Bug Creek, and Verde River.

Operations and maintenance activities along transmission lines and at communication sites are described in **Appendix 1B**. In particular, Tables 7 and 8 in **Appendix 1B** identify activities anticipated during the Proposed Action or alternatives. Table 9 in **Appendix 1B** identifies activities that are not part of the Proposed Action or alternatives; those would require separate authorizations from appropriate land management or water resources agencies.

- Scoping Concern: Water quality in streams crossed by transmission lines could be reduced by construction or maintenance activities in the ROWs.

Water Quality Impacts from Transmission Line Construction or Maintenance Activities, 3-Unit Operation	Water Quality Impacts from Transmission Line Construction or Maintenance Activities, 2-Unit Operation
No impacts to water quality would occur from operation and maintenance activities conducted in accordance with permit conditions along either transmission system during the Proposed Action.	Potential impacts would be the same as those described for the 3-Unit Operation.

Activities that could result in adverse effects to water resources from a Proposed Action option include:

- Applications of herbicides, pesticides or rodenticides;
- Vehicle and equipment staging along transmission line ROWs; and
- Erosion control projects along transmission line ROWs.

These activities could primarily affect surface water or shallow groundwater resources. Adverse effects to water quality could result if spills or leaks of fuels, lubricants, or other chemicals occurred in or near stream channels, or if disturbance led to accelerated erosion and sedimentation. In addition, if toxic levels of chemical treatments were directly applied to waterbodies or transported in runoff, adverse surface water quality and related habitat impacts could result.

To avoid such impacts, herbicides and pesticides would be managed within appropriate material storage and handling guidelines, and would be selected and applied according to land management agency procedures and approvals. Impacts from other activities near channels, or through channel crossings, would be avoided by compliance with approved nationwide permits (e.g., U.S. Army Corps of Engineers Nationwide Permit 12), federal or tribal agency ROW permit reviews and approvals, and corresponding permit provisions or stipulations. These would address the staging of vehicles, equipment, and fluids with respect to streams, washes, and floodplains; spill prevention, response, and reporting; crossing conditions and erosion controls; and other best management practices.

Because of implementing these practices and procedures, and complying with other agency requirements, none to negligible impacts to water resources would occur from operation and maintenance activities along either transmission system during the Proposed Action operating period.

3.7.4.2.4 Project Impact Summary – All Project Components

As mentioned in Section 3.7.4.1 (Assumptions, Impact Methodology, and Issues), recent background conditions (2010 through 2014) formed the primary basis for the preceding impact assessments. Some longer-term data also were used to examine potential future impacts from a Proposed Action option. Cumulative effects (from past, present, and reasonably foreseeable activities) are examined in following parts of this water resources section.

At the NGS, the direct and indirect impact assessment for the Proposed Action focuses on the potential for:

- Impacts to surface water and the N-Aquifer from plant operations and facilities;
- Water supply withdrawal effects on Lake Powell; and
- Airborne deposition impacts from selected trace elements on surface water quality in Lake Powell and the Colorado River downstream.

No impacts to water resources would occur at the facility due to proposed operations and maintenance. Environmental programs and compliance with regulatory requirements at NGS (e.g., CCR regulations), and implementation of the Groundwater Protection Plan and Perched Water Dewatering Plan would protect the N-Aquifer and surface water. Ultimately, plant closure, materials disposition, and plant site reclamation would be conducted as described in the decommissioning description (**Appendix 1B**) implemented pursuant to applicable laws and regulations. Withdrawals from Lake Powell would create negligible impacts on reservoir water levels and the extent of the lake water surface. Negligible amounts of arsenic, mercury, or selenium would be deposited on Lake Powell or the nearby Colorado River from plant emissions. Overall impacts to water resources from either Proposed Action options at the NGS would be none to negligible.

At the Proposed KMC, the direct and indirect impact assessment for a Proposed Action option focuses on the potential for:

- Mine-related pumping impacts to N-Aquifer groundwater levels and water quality;
- Reduced discharges in N-Aquifer springs and supported stream baseflows;
- Reduced groundwater levels and water quality in the shallower Wepo and alluvial aquifer zones;
- Reduced flow rates, occurrence, or water quality at shallow springs and seeps, and corresponding effects on existing water uses in and near the coal leasehold;

- Reduced flows or water quality in stream channels and corresponding effects on existing water uses in and near the coal leasehold; and
- Additional retention of surface runoff in ponds and impoundments, and the suitability of retained water quality to support water uses in the mine-area locale.

Mine related pumping would create predicted maximum N-Aquifer drawdowns of about 35 feet at Forest Lake in the year 2046, about 18 feet at Chilchinbito in 2040, about 16 feet at Pinon in 2051, and about 14 feet at Kayenta in 2097. At other communities, predicted maximum drawdowns range from essentially zero up to about 12 feet. Negligible drawdowns would occur at Tuba City and Moenkopi. The maximum increases in pumping lift due to the Proposed Action (3.1 to 3.7 percent) would occur at Kayenta, Forest Lake, and Chilchinbito. The predicted range in percent increased pumping lift for all communities varies from zero to a maximum of 3.7 percent; the median value is 0.7 percent. Based on the predicted results, these effects would comprise negligible to minor impacts.

There would be no changes to N-Aquifer water quality. Effects on stream baseflows would be none to negligible, depending on the stream. Similarly, the potential impacts to discharges at N-Aquifer springs from either Proposed Action options would be none to negligible.

During either Proposed Action options, groundwater levels in the Wepo Formation and alluvial aquifers within and adjacent to the leasehold would continue to vary with background climatic conditions (including drought or wet cycles), local differences in recharge, and mine pit configurations. Project impacts would be none to negligible. Water quality effects in the Wepo Formation, alluvial aquifers, and associated springs and seeps would range from none to minor, and would be localized to a few isolated locations within the leasehold. Any impacts to existing water uses would be mitigated by PWCC ponds and impoundments and ongoing seep mitigation.

The amount of watershed area directed to ponds and impoundments would change over time as mining and reclamation move across proposed mine areas. There would be moderate hydrologic impacts from shifts to retention storage along Moenkopi Wash or Dinnebito Wash within and adjacent to the leasehold. These would decline after reclamation at the end of proposed mining, and would not affect flows available for distant uses along Moenkopi or Dinnebito washes. In addition, permanent ponds would mitigate impacts to uses and improve local water availability on and near the leasehold. Stream water quality would continue to be influenced mainly by background conditions. Trace element impacts would not occur or would be negligible. Sediment controls would restrict erosion and sedimentation impacts to negligible levels during mining, and reclaimed sediment yields would mimic undisturbed conditions. Minor localized impacts from TDS and sulfate concentrations could occur to stream water quality, but would be mitigated by suitable water quality in ponds and impoundments.

Operation and maintenance of transmission systems, and coordination with applicable land management agencies for these activities, is described in **Appendix 1B**. NGS would decommission the transmission systems in accordance with the requirements of respective agencies and the sequence described in **Appendix 1B**. By implementing the operations and maintenance plans and complying with permit requirements and other agency stipulations, none to negligible impacts to water resources would occur along transmission line ROWs.

3.7.4.2.5 Cumulative Impacts

Cumulative impacts are based on considerations of past, present, and reasonably foreseeable actions and their potential effects on water resources in combination with the Proposed Action. Specifically, these other actions include:

- Trace element emissions from other regional coal-fired generation sources;
- The Glen Canyon Dam Long-term Experimental and Management Plan;

- The Navajo-Gallup Pipeline Project in New Mexico;
- The proposed Lake Powell Pipeline Project in Utah;
- Past, present and future N-Aquifer pumping by communities;
- Historic N-Aquifer pumping by PWCC; and
- Other downstream tribal surface water diversions and retention structures for livestock watering and agricultural production.

The first four listed activities were detailed in Section 3.0, under “Cumulative Impacts.” The last two activities involve potential effects from the proposed KMC and other users; these are further detailed in the text below. The potential mine-related cumulative effects also are summarized below in **Tables 3.7-26** and **3.7-27**. This cumulative assessment emphasis is on the Proposed Action 3-Unit Operation; cumulative impacts from the 2-Unit Operation would be slightly less for concerns related to airborne deposition and withdrawals from Lake Powell.

From public and agency scoping, cumulative impact concerns include:

- Combined airborne deposition of As, Hg, and Se from NGS and other sources could affect the quality of surface water and sediments in Lake Powell, and in parts of the Colorado River and San Juan River watersheds;
- Combined water supply withdrawals from Lake Powell would further reduce water levels and the reservoir extent;
- Past, present, and future N-Aquifer pumping at communities would interact with mine-related pumping effects to further decrease N-Aquifer water levels and contributions to connected springs or baseflows in streams;
- Past mine-related pumping effects have created drawdown in N-Aquifer wells and historically reduced groundwater contributions to springs and baseflows in streams;
- Land fissures and landslides in the Blue Gap area and elsewhere could be caused by historic or proposed groundwater pumping at the coal leasehold or from anticipated increased community pumping over time; and
- Potential effects of climate change on water resources availability within the study areas (Section 3.2).

3.7.4.2.5.1 Trace Element Emissions from Regional Coal-fired Generation Sources

- Scoping Concern: Airborne emissions from regional coal-fired power plants could contribute additional levels of arsenic, mercury, selenium, and acid-forming compounds to major waterbodies in the study area, including the Colorado River, San Juan River, and Lake Powell.

Water Quality Impacts in Major Waterbodies from Airborne Emissions, 3-Unit Operation	Water Quality Impacts in Major Waterbodies from Airborne Emissions, 2-Unit Operation
Cumulative impacts to surface water resources within the near-field study area and the Colorado River gap regions from cumulative source deposition of arsenic, mercury, and selenium would be none to negligible. Along the San Juan River, cumulative mercury deposition impacts would be none to negligible, arsenic impacts would be minor, and selenium impacts would generally be moderate but could be greater. Acid deposition impacts from NGS would not occur in the water resources study area, and so would not contribute to cumulative impacts.	Potential impacts would be somewhat less than those described for the 3-Unit Operation.

Other sources of trace element deposition include the Four Corners Power Plant and the San Juan Generating Station (EPRI 2016; Ramboll Environ 2016a). Predicted combined airborne deposition rates were modeled for the cumulative source cases using an approach similar to that used for the direct impact analysis. For the near-field area (20-km radius from NGS), the predicted arsenic and selenium contributions from these Other Cumulative Sources to surface water concentrations in mg/L are zero out to ten decimal places (see the bar charts in the ERA appendices). For total and dissolved mercury, contributions in mg/L are zero out to six and eight decimal places, respectively. Because of these values, impacts to surface water resources within the near-field study area from cumulative source deposition of these trace elements would be none to negligible.

Predicted trace element airborne deposition rates in the southwest gap region (Colorado River downstream of Lake Powell) and the northeast gap region (see the Ecological Risk Assessment) are generally similar to those described for the near-field conditions. They may vary by an order of magnitude, but are still negligible in relation to baseline conditions. Because of this, impacts to surface water resources within the gap regions from cumulative source deposition of these trace elements would be none to negligible.

Along the San Juan River, predicted combined contributions of total and dissolved mercury would be similar to those described for the near-field (20-km) conditions. Related mercury impacts would be none to negligible. For arsenic, total and dissolved combined contributions are predicted to be greater along the San Juan River, on the order of 0.00012 mg/L (0.12 μg/L) as a worst case. Baseline dissolved arsenic concentrations in the river range from approximately 1.2 μg/L (**Table 3.7-7**) to 2.2 μg/L (Ramboll Environ 2016a). Because of this, minor impacts to surface water quality would occur from combined arsenic depositions along the San Juan River. For selenium, baseline dissolved concentrations in the San Juan River are approximately 1.1 μg/L (**Table 3.7-7,** and Ramboll Environ 2016a). Combined selenium contributions are predicted to be 0.33 μg/L (a 30 percent increase) as a worst-case. Because of this, under more typical effects, moderate impacts to surface water quality would occur from combined selenium depositions along the San Juan River.

These effects would subject to further environmental processes within the aquatic ecosystem. The ecological effects of predicted water quality impacts from arsenic and selenium in combined-source depositions along the San Juan River are further examined in the ERA and Aquatic Biology assessments.

3.7.4.2.5.2 Cumulative Effects on Lake Powell Extent and Water Levels from Combined Project Withdrawals

- Scoping Concern: Other federal or state actions or reasonably foreseeable projects would increase surface water withdrawals from Lake Powell, reducing its surface extent and the depth of water needed for uses along the shorelines (e.g., recreation, biological habitats).

Reduction of Lake Powell Extent or Depth from Additional Withdrawals by Other Projects, 3-Unit Operation	Reduction of Lake Powell Extent or Depth from Additional Withdrawals by Other Projects, 2-Unit Operation
Under normal pool conditions, potential reservoir surface acreage reduction would be about 540 acres, with a reduction in depth of about 9 inches. These would be negligible impacts. Under severe drought conditions, potential reservoir surface acreage reduction would be about 683 acres, with a reduction in depth of about 19 inches. These would be negligible or greater impacts, depending on location, recreational or commercial uses, or shoreline habitats.	Potential impacts would be negligible, and somewhat less than those described for the 3-Unit Operation.

Several existing or reasonably foreseeable actions are of interest with respect to the potential reservoir impact concerns described above. These actions are summarized below, and then assessed for cumulative impacts.

<u>Glen Canyon Dam Long-term Experimental and Management Plan</u>

This planning effort was previously described in Section 3.0. Management of Lake Powell releases is not part of the NGS Proposed Action or any alternative. If any downstream effects occurred from managing Lake Powell releases, they would not be due to any NGS project operations. Most Long-term Experimental and Management Plan alternatives would not change releases (Reclamation 2015b). Monthly release volumes under Alternative C in August through November would be lower than those under most other alternatives to reduce sediment transport rates during the monsoon period. Release volumes in the high power demand months of December, January, and July would be increased to compensate for water not released in August through November, and volumes in February through June would be patterned to follow the monthly hydropower as defined by the contract rate of delivery (Reclamation 2015b).

Under Alternative F of the plan, peak flows would be lower than pre-dam magnitudes to reduce sediment transport and erosion given the reduced sand supply downstream of the dam. Peak flows would be provided in May and June, which corresponds well with the timing of the pre-dam peak. The variability in flows within the peak also would serve to water higher elevation vegetation. There would be no within-day fluctuations in flow (Reclamation 2015b).

If Long-term Experimental and Management Plan Alternatives C or F were to be implemented, seasonal changes from current water temperature and dissolved oxygen regimes would result in the Colorado River downstream of Lake Powell (the “Southwest Gap Region”). The magnitudes and extents of such changes are unknown, but there would not be an incremental effect caused by any NGS alternative.

<u>Navajo-Gallup Pipeline Project</u>

The Navajo-Gallup Pipeline would use water exchanged in storage within Navajo Lake outside of the study area. No additional water would be removed from the San Juan River downstream of Navajo Dam that would not first originate from upstream reservoir releases (Reclamation 2009). An anticipated average annual return flow of approximately 1,870 acre-feet would occur at the western end of the project. Cumulative effects to Lake Powell water levels or water quality would not occur.

Proposed Municipal Lake Powell Pipeline Project

As described at the beginning of Chapter 3.0, the proposed Lake Powell Pipeline project would withdraw approximately 86,249 acre-feet of water per year at full capacity. The effects of these withdrawals are compared to NGS withdrawals (3-Unit Operation and 2-Unit Operation) under normal and drought conditions in **Tables 3.7-26** and **3.7-27**.

As can be seen from **Table 3.7-26**, the total effect of combined withdrawals with the Proposed Action 3-Unit Operation would lower Lake Powell by about 9 inches under normal pool conditions, and by about 19 inches under extreme drought conditions. The reductions in lake extent would be about 540 acres and 685 acres under the normal and drought conditions, respectively. Seasonal conditions and wind effects would modify these estimates. Still smaller reductions are estimated for the Proposed Action 2-Unit Operation in the second table. Because the lake occupies about 160,800 acres at normal pool and about 73,800 acres at its historic drought elevation, these effects would be negligible impacts.

Table 3.7-26 Cumulative Effects with Proposed Action 3-Unit Operation Withdrawals on Lake Powell Extent and Depth

Assumed Lake Powell Pool Condition, (Water Elevation, feet amsl)[1]	Diversion Source	Anticipated Withdrawal, (acre-feet/yr)	Withdrawal Effects, Reduction in Reservoir Extent (acres)	Withdrawal Effects, Reduction in Reservoir Depth (inches)
Full (3,700)	Proposed Action, 3-Unit Operation	29,000	132.1	2.1
Full (3,700)	Reasonably Foreseeable (Lake Powell Pipeline)	86,250	407.0	6.4
Full (3,700)	Total	114,250	539.2	8.6
Drought (3,555)	Proposed Action, 3-Unit Operation	29,000	167.1	4.6
Drought (3,555)	Reasonably Foreseeable (Lake Powell Pipeline)	86,250	515.6	14.1
Drought (3,555)	Total	114,250	683.0	18.7

[1] Tabulated values reflect arithmetic rounding differences and interpolation from existing Lake Powell data.

Source: Reclamation 2009, 2007; Washington County Water Conservancy District 2016

Table 3.7-27 Cumulative Effects with Proposed Action 2-Unit Operation Withdrawals on Lake Powell Extent and Depth

Assumed Lake Powell Pool Condition, (Water Elevation, feet amsl) [1]	Diversion Source	Anticipated Withdrawal, (acre-feet/yr)	Withdrawal Effects, Reduction in Reservoir Extent (acres)	Withdrawal Effects, Reduction in Reservoir Depth (inches)
Full (3,700)	Proposed Action, 2-Unit Operation	18,700	88.3	1.4
Full (3,700)	Reasonably Foreseeable (Lake Powell Pipeline)	86,250	407.0	6.4
Full (3,700)	Total	104,950	495.3	7.8
Drought (3,555)	Proposed Action, 2-Unit Operation	18,700	111.6	3.0
Drought (3,555)	Reasonably Foreseeable (Lake Powell Pipeline)	86,250	515.6	14.1
Drought (3,555)	Total	104,950	627.4	17.2

[1] Tabulated values reflect arithmetic rounding differences and interpolation from existing Lake Powell data.

Source: Reclamation 2009, 2007; Washington County Water Conservancy District 2016.

3.7.4.2.5.3 Cumulative Effects on N-Aquifer Water Levels, Water Quality, and Uses

- Scoping Concern: Past groundwater drawdown from mine-related pumping combined with past community water supply withdrawals has created greater depths to water in N-Aquifer wells and reduced flows at associated streams and springs.

Past Impacts of Mine-Related and Community Pumping on N-Aquifer Wells, Stream Baseflows, and Springs, 3-Unit Operation	Past Impacts of Mine-Related and Community Pumping on N-Aquifer Wells, Stream Baseflows, and Springs, 2-Unit Operation
Historical impacts to N-Aquifer wells from mine-related pumping have been negligible to moderate. Community pumping also has generated historical drawdowns in N-Aquifer wells. Historical mine-related contributions to previous baseflow and spring impacts range from none to negligible. Past impacts on baseflows due to combined source effects range from none to moderate, depending on which channel is considered.	Historical impacts are the same as those described for the 3-Unit Operation.

Mine-related pumping has withdrawn water supplies from the N-Aquifer since the inception of mining in the 1970s. Pumping rates were greatest before 2006, when coal slurry deliveries to the Mojave Generating Station ceased. Mine-related drawdowns historically occurred at N-Aquifer wellfields. Since the cessation of pumping for the coal slurry pipeline at the end of 2005, water level recovery has occurred in some wells. These effects are detailed in **Appendix WR-9**, Attachment A. Community withdrawals also affect water levels in N-Aquifer wells. These community effects also are discussed and shown in **Appendix WR-9**, where the accompanying hydrographs indicate both mine-related and community pumping effects since 1970.

For N-Aquifer water supply wells with monitoring data, **Appendix WR-9**, Attachment A provides hydrographs showing measured and PWCC model simulated depth to water for 1) combined PWCC and community pumping and 2) community pumping only. These effects are scaled on the left-hand vertical axis of the hydrographs. Drawdown since 1970 due to PWCC mine-related pumping is given on the right-hand vertical axis of the hydrographs.

Well 4T-523 (Forest Lake NTUA1) is the community water supply well closest to the PWCC leasehold and exhibits the greatest effect of mine-related pumping on N-Aquifer water levels. As shown on **Appendix WR-9, Figure WR-9A.2**, the right-hand vertical axis indicates that up to about 220 feet of drawdown occurred in the well due to PWCC mine-related pumping between 1970 and roughly the end of 2005. After cessation of slurry pipeline-related pumping at the end of 2005, the water level has been recovering and is simulated to continue to recover through about 2028 (left-hand vertical axis). After 2029 the water level is expected to begin to decline again in response to the Proposed Action mine-related pumping and a projected future increase in Forest Lake community withdrawals. Once PWCC pumping stops completely in 2057, the simulated water level recovers slightly before continuing its decline due to the projected increase in Forest Lake withdrawals through 2110.

Combined PWCC and community pumping at Forest Lake NTUA1 increased the simulated depth to water from about 975 to about 1,215 feet bgs in Year 2006, as depicted on the left-hand vertical axis. This is a water level change (increased depth) of about 240 feet. Of that, approximately 20 feet of the increase was due to community pumping and about 220 feet was due to PWCC pumping. The top of the N-Aquifer screened interval at Forest Lake is 1,870 feet bgs, at the maximum drawdown due to PWCC pumping there was still 655 feet of water above the top N-Aquifer producing interval.

Other community wells show less effects of historical PWCC pumping. For example, at Pinon PM6 (**Appendix WR-9, Figure WR-9A.10**) the simulated maximum historic PWCC drawdown reached about 102 feet in about Year 2008. At Kayenta West (**Appendix WR-9, Figure WR-9A.4**), the maximum drawdown due to historic PWCC pumping was about 23 feet. The effects of mine-related pumping decrease logarithmically from the PWCC production wells on the leasehold. On the Hopi Reservation, the maximum drawdown due to mine related pumping was slightly over 16 feet in 2010 at Kykotsmovi (**Appendix WR-9, Figures WR-9A.7** and **WR-9A.8**).

At each of the foregoing wells (and all other N-Aquifer wells), the depth to water at the time of maximum mine-related drawdown is less than the predicted depth to water in 2110, as noted below. This is due to the projected increasing future demand, as provided by the tribes, for N-Aquifer water by the communities on Black Mesa. A listing of examples from **Appendix WR-9**, Attachment A follows, indicating their maximum simulated historical depths to water due to PWCC pumping, and their maximum projected future depths to water (from simulated combined PWCC and community pumping):

- Forest Lake NTUA1: 1,215 feet bgs (simulated historical maximum); 1,258 feet bgs (simulated future combined maximum);
- Pinon PM6: 672 feet bgs (simulated historical maximum); 959 feet bgs (simulated future combined maximum);
- Keams Canyon: 422 feet bgs (simulated historical maximum); 445 feet bgs (simulated future combined maximum).
- Kayenta West (8T-541): 310 feet bgs (simulated historical maximum); 455 feet bgs (simulated future combined maximum).

The impact of drawdown in water levels on an aquifer is measured by either a reduction in aquifer saturated thickness or by the cost of lifting water to the surface. As noted above, the well with the greatest mine-related drawdown (Forest Lake NTUA 1) remains fully saturated under maximum PWCC drawdown. The cost to produce water from a well, all other factors being equal, is directly proportional to the lift (depth to water) in the well. The increase in cost due to mine-related withdrawals can be approximated by the increase in lift caused by PWCC pumping. At Forest Lake NTUA 1 the maximum increase in lift due to PWCC pumping occurred in 2006 and was about 216 ft. This represented an increase in lift of 22 percent, a moderate impact, and well recovery has occurred since then. The maximum increase in lift at Pinon due to PWCC pumping was about 19 percent, in 2008, a moderate impact, and PWCC drawdown effects there are decreasing. At Kayenta West, the maximum percent increase in lift due to PWCC pumping was about 13 percent, in 2008, and PWCC drawdown effects are decreasing. At Keams Canyon 2, the maximum percent increase in lift due to PWCC pumping was about 13 percent, in 2010, and PWCC drawdown effects are decreasing. Small historical impacts occurred at other wells, and were negligible to minor.

As noted on **Table 3.7-15**, under the Proposed Action the maximum increase in lift going forward at Forest Lake is 3.1 percent and the maximum for all N-Aquifer community wells is 3.7 percent. These would be negligible future impacts.

Past combined pumping effects on stream baseflows are indicated in **Table 3.7-17**, based on modeling conducted for the EIS. Historical combined pumping effects are implied by the difference in flows (cfs) between 1956 and 2019. Historical combined pumping effects (mine-related plus community) on baseflows are estimated to range from almost zero (-0.24 percent on Moenkopi Wash), to over 20 percent on Polacca Wash (**Table 3.7-17**). Substantial parts of the estimated differences in baseflows are due to community pumping and evapotranspiration; mine-related pumping effects range from zero to about 6.3 percent of the estimated baseflow changes since 1956. Mine-related contributions to these impacts range from none to negligible on most channels. Baseflows on Polacca Wash depend substantially on D-Aquifer discharges to the stream. Mine-related impacts to Polacca Wash baseflows are negligible to minor.

- Scoping Concern: Past and future groundwater drawdown from mine-related pumping could have created (or would create) dessication cracks in the land surface and landslides along cliff edges in the Blue Gap area.

Past and Future Impacts from Fissures and Landslides Generated by N-Aquifer Pumping, 3-Unit Operation	Past and Future Impacts from Fissures and Landslides Generated by N-Aquifer Pumping, 2-Unit Operation
No fissures from mine-related groundwater pumping have occurred in the N-Aquifer study area. No impacts in the form of ground dessication cracks or landslides have occurred from past mine-related pumping, or would occur from proposed mine-related pumping. These features result in locations prone to them, from natural causes including extreme drought, erosion, and seismic activity.	Historical and potential impacts would be the same as those described for the 3-Unit Operation.

Mine-related pumping has withdrawn water supplies from the N-Aquifer since the inception of mining in the 1970s. Pumping rates were much greater before 2005, when coal slurry deliveries to the Mojave Generating Station ceased. Open surface dessication cracks (colloquially called “fissures”) and mass failures or “slips” on steep sideslopes have occurred in the Blue Gap area (within the cumulative effects study area) during the pumping period. Dessication features are occurring more extensively in Arizona, particularly in more clayey alluvial valleys such as Blue Gap, as a result of extended drought conditions (Harris 2004). Rather than N-Aquifer pumping, these features result from loss of moisture in the alluvial sediments due to drought. They are present elsewhere in Arizona in similar settings where no pumping has occurred (Harris 2004). The N-Aquifer rock matrix is not conducive to pumping subsidence. This is further addressed in Section 3.3, Geology and Landforms. There also has been fairly common recent seismic activity in the region, particularly along the Colorado River. These dessication cracks result from extreme drought acting on moisture conditions in silty and clayey alluvium. Natural factors (such as seismic activity and natural erosion at the toes and steep sideslopes of escarpments) have created mass failures and rock falls along the escarpment at the north end of the valley.

Mine-related pumping would continue in conjunction with community pumping from the N-Aquifer. Both activities would exist within a natural context of seismic events, cliff erosion, and periodic, lengthy droughts and climate change. These natural background conditions would create landslides and escarpment "retreat" along steep slopes and cliffs, and dessication cracks in clayey or silty alluvial valley deposits. Although these features do not result from mine-related N-Aquifer pumping, land surface dessication cracks and landslides would continue to result from natural background causes during an action alternative, or the No Action, and afterward. In the Blue Gap area, natural mass failures (with contributions from seismic events) are the major natural background causes of rock falls and landslides. Periodic lengthy droughts and the clayey and silty alluvial valley sediments have created the land surface dessication cracks in the Blue Gap area. No mine-related impacts have or would occur.

- Scoping Concern: Future groundwater drawdown from proposed mine-related pumping combined with projected community water supply withdrawals would create greater depths to water in N-Aquifer wells.

Impacts of Combined Mine-Related and Community Pumping on N-Aquifer Wells, 3-Unit Operation	Impacts of Combined Mine-Related and Community Pumping on N-Aquifer Wells, 2-Unit Operation
None to minor effects from mine-related pumping would occur. As described below (for the No Action Alternative), increasingly larger effects would result over time from projected community pumping.	Potential impacts would be the same as those described for the 3-Unit Operation.

The projected direct impact of pumping at the proposed KMC on water levels in the N-Aquifer community wells was described previously. Proposed Action mine-related pumping would remain relatively consistent through Year 2044 and then decline in stages, ending in 2057. Future community pumping will continue indefinitely. To assess the cumulative effects of both proposed mine-related pumping and projected future community pumping, it was necessary to develop a basis for estimating future community growth and water demand.

As discussed in the direct impacts assessment and in **Appendix WR-9**, the estimate of future water level change is supported by a numerical groundwater model of Black Mesa prepared for PWCC by Tetra Tech, Inc. (Tetra Tech 2014, Tetra Tech 2015a,b). The model has been reviewed by the USGS and determined to be suitable for use in predicting water level change in N-Aquifer wells within the model domain. Details of the model, the USGS review, and selected model files are presented in **Appendices WR-9** and **WR-10**. The PWCC model was run to estimate the time at which N-Aquifer water levels would cease to decline due to the Proposed Action mine-related pumping. This analysis predicted that maximum impacts due to that pumping would be reached prior to 2111 (Tetra Tech 2014). Based on this finding, community withdrawals were estimated through the year 2110.

The approach to estimating future community water demands was developed in coordination with the Navajo Nation, the Hopi Tribe, federal agencies, and project participants. The process and conclusions are described in a separate Technical Memorandum "Proposed Approach to Projecting Water Demands from N-Aquifer Groundwater Resources, Navajo Generating Station-Kayenta Mine Complex EIS, September 2014." The basis of future community water demands are the assumptions that:

1. The average rate of population growth will be 1.3 percent compounded annually; and
2. The eventual maximum water demand ("target demand") of 120 gallons per capita per day (gpcd) will occur at major growth centers.

Implementing this parameter set for input to the groundwater model included the following:

- The 2010 U.S. Census data (as adjusted for undercounts since 1990) is used as starting populations for each of the existing community well and distribution systems.
- The average pumping rate for the past 3 years (USGS pumping data) is used to calculate an initial pumping rate and a starting per capita demand (gpcd).
- The following community's demands ramp-up in equal 10-year increments from their initial pumping rates and demands (gpcd) beginning in 2010, achieving the 120 gpcd target demand in 2070 and remaining constant thereafter:
  - Tuba City;
  - Kayenta;
  - Pinon;
  - Moenkopi District;
  - Shonto; and
  - Polacca.
- Remaining existing communities ramp-up in equal 10-year increments from their initial pumping rates and demands (gpcd) beginning in 2010, to a final target demand of 100 gpcd in 2070 and remaining constant thereafter.
- Demands and population growth at "new" Hopi communities listed below are brought online in the years assumed and shown below, with the 120 gpcd target demand met at the outset:
  - Tawa'ovi: 2025, with initial population of 768;
  - Howell Mesa West, East: 2035, 2045, respectively, with initial populations of 768 each;
  - Spider Mound: 2060, with initial population of 432; and
  - South Oraibi: 2070, with initial population of 432.
- Hopi Arsenic Mitigation Project wells would be constructed and come online in 2020 and 2030 as currently existing Hopi high-arsenic wells are phased out.
- Pumping for the Many Mules project (approximately 300 acre-feet per year), which uses water produced from PWCC Well NAV2, starts in 2016.

The effect of the above community demands is to substantially increase the total groundwater withdrawn from the N-Aquifer during the model simulation period (through 2110). **Table 3.7-28** gives the annual withdrawals for key communities in 2011 and 2110 and the percent change.

Table 3.7-28 Community N-Aquifer Water Demands 2011 and 2110

Community	2011 Withdrawal (acre-feet per year)	Predicted 2110 Withdrawal (acre-feet per year)	% Change
Navajo			
Tuba City	1,162	4,751	309
Kayenta	441	3,188	623
Shonto	166	688	314
Dennehotso	60	1,207	1,912
Chilchinbito	64	498	678

Table 3.7-28 Community N-Aquifer Water Demands 2011 and 2110

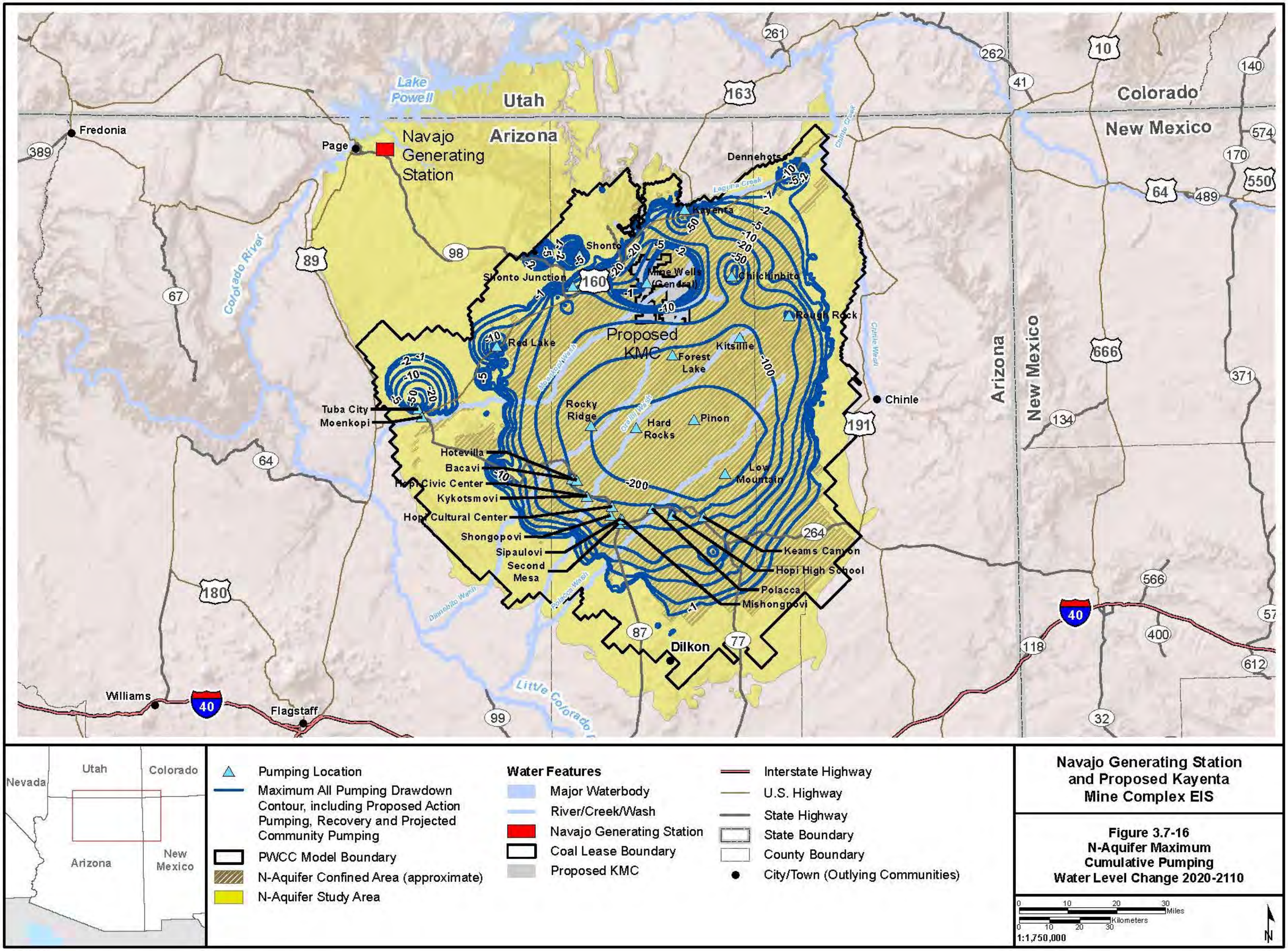
Community	2011 Withdrawal (acre-feet per year)	Predicted 2110 Withdrawal (acre-feet per year)	% Change
Rough Rock	61	452	641
Forest Lake	15	120	700
Pinon	337	1,412	319
Hard Rock	50	476	852
Low Mountain	0	323	-
Shonto Junction	93	502	440
Red Lake	59	1,142	1,836
Rocky Ridge	6	49	717
Hopi			
Moenkopi	87	319	267
Hotevilla	25	154	516
Bacavi	24	154	542
Kykotsmovi	67	123	84
Hopi Civic Center	2	66	3,200
Shungopavi	38	51	34
Hopi Cultural Center	7	0[1]	-
Polacca	185	0[1]	-
Hopi High School	17	0[1]	-
Keams Canyon	59	0[1]	-
Mishongnovi	5	0[1]	-
Second Mesa	7	0[1]	-
HAMP[1]	0	1,508[1]	-
Oraibi[2]	0	51	-
South Oraibi[2]	0	81	-
Spider Mound[2]	0	90	-
Howell Mesa[2]	0	190	-
Total	**3,037**	**17,595**	**479**

[1] Wells replace existing high arsenic wells at Hopi CC, Polacca, Mishonghovi, and Second Mesa in 2020 and Hopi HS, Keams Canyon in 2030.

[2] New (Future) Hopi Communities.

HAMP = Hopi Arsenic Mitigation Project.

As noted in **Table 3.7-28**, the total annual 2110 community groundwater withdrawal from the N-Aquifer is nearly six times the 2011 volume. This increase in pumping is accompanied by a decline in water levels in community wells. Since the growth in demand is driven by a compounding population growth rate, the maximum water level drawdown in wells generally occurs at the end of the projection period (i.e., 2110). The maximum projected N-Aquifer water level drawdown resulting from all proposed mine-related and community pumping is shown on **Figure 3.7-16**.



Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 3.7-16
N-Aquifer Maximum Cumulative Pumping Water Level Change 2020-2110

7/20/2016

To assess the portion of the cumulative effects created by Proposed Action mine-related pumping on community water supply wells, the separate increase in lift required to pump water to the surface due to planned PWCC pumping was distinguished from the predicted overall pumping water level resulting from combined community and project pumping. As discussed in the direct impacts text and previously shown in **Table 3.7-14,** the maximum drawdown in well water levels due to proposed mine-related pumping occurs at different years in different locations. To assess the relative impact of proposed PWCC pumping on key communities, the cumulative effects on depths to water (from both mining and community pumping), and the separate percent increases in lift due only to PWCC pumping were calculated for the year of maximum drawdown. The results of these calculations are given in **Table 3.7-29** below.

Table 3.7-29 Maximum Increase in Lift Due to Proposed Mine-Related Pumping During Combined Pumping Activities

Community	Proposed Action Maximum Year Depth to Water (feet bgs)[1]	No Action Alternative Maximum Year Depth to Water (feet bgs)	Increase in Lift Due to Mine-Related Pumping (PWCC Only) (%)
Navajo			
Kayenta	820	807	1.7
Shonto	375	375	0.0
Dennehotso	32	32	0.0
Chilchinbito	609	591	3.0
Rough Rock	727	724	0.3
Forest Lake	1,145	1,110	3.0
Pinon	898	882	1.7
Hard Rock	785	769	2.1
Shonto Junction	179	179	0.1
Red Lake	238	238	0.0
Rocky Ridge	599	587	2.0
Tuba City	210	210	0.0
Hopi			
Moenkopi	616	616	0.0
Hotevilla	1,002	999	0.3
Bacavi	1,024	1,021	0.3
Low Mountain	833	820	1.5
Kykotsmovi	280	277	0.9
Hopi Civic Center	440	437	0.6
Shungopavi	964	962	0.2
HAMP[2]	589	577	2.0

[1] Depth to water due to combined proposed PWCC and community pumping at year of maximum drawdown due to PWCC pumping (3-Unit Operation).

[2] Wells replace existing high arsenic wells at Hopi CC, Polacca, Mishongnovi, and Second Mesa in 2020, and Hopi HS and Keams Canyon in 2030; maximum depth to water occurs after 2030.

HAMP = Hopi Arsenic Mitigation Project.

As would be expected given its proximity to the proposed KMC leasehold, the maximum increase in lift due to the Proposed Action mine pumping occurs at Forest Lake. The range in percent increased lift at Black Mesa community wells varies from zero to 3 percent; the median value is 0.6 percent.

With respect to **Figure 3.7-16**, the maximum cumulative water-level change contours indicated on the figure would not occur everywhere at the same time. Similar to the previous discussion of **Figure 3.7-12**, the simulated maximum cumulative change contours are spatial in nature, but the timing of drawdown in the N-Aquifer would vary between specific locations. This is due to variations in pumping demands at different locations at different times, as well as the response of the aquifer to those demands. An additional factor in the simulated maximum cumulative water level change is that proposed pumping at the proposed KMC would cease in the year 2057, whereas the simulation period employed to identify groundwater effects extends to the year 2110. Because of this, proposed pumping in the coal lease area would cease more than 50 years before the end of the simulation period. Some recovery would occur in the leasehold locale as a result. At the same time, projected community demands on the aquifer would continue to increase.

Figure 3.7-16 depicts the maximum projected effects of the interaction between the proposed mine-related withdrawals and anticipated community withdrawals from the N-Aquifer. These could create negligible to severe impacts to the height of lift required to pump groundwater to the community water systems. As noted in **Table 3.7-28**, community withdrawals increase by a factor of nearly 6 times between 2011 and 2110. After mine-related pumping ceases in 2057, drawdown in areas affected by PWCC pumping will decrease (recover) while drawdown due to community pumping will increase over time due to the projected increase in population and resulting water use. This is evident in comparing drawdown contours on **Figure 3.7-16** to those on **Figure 3.7-15**, water level change due to PWCC pumping is limited to the confined area of the aquifer (**Figure 3.7-15**) while more drawdown in the unconfined aquifer in the area of Tuba City and Moenkopi can be seen in **Figure 3.7-16**, as a result of ongoing community withdrawals.

- Scoping Concern: Flow reductions at springs/seeps could occur from the combination of proposed mine-related pumping and community pumping (D- and N-Aquifers).

Impacts of Combined Mine-Related and Community Pumping on Springs, 3-Unit Operation	Impacts of Combined Mine-Related and Community Pumping on Springs, 2-Unit Operation
No change in flow at any of the USGS monitored springs is predicted as a result of the Proposed Action mine pumping under either the 3-Unit Operation or 2-Unit Operation. Negligible mine-related impacts are predicted at other D- or N-Aquifer springs. Thus, potential impacts at springs are predicted to result from cumulative increases in community pumping over time. These cumulative impacts would range from none to severe depending on hydrologic connections between springs and N-Aquifer wells.	Potential impacts would be the same as those described for the 3-Unit Operation.

Springs and seeps were grouped based on their geographic and hydrogeologic similarity. Spring and seep groups are shown previously on **Figure 3.7-14** and previously described in the assessment of direct impacts on springs. As with the potential direct impact of proposed PWCC pumping on springs, the PWCC 3-D groundwater flow model has been utilized to evaluate potential changes in flow at springs and seeps due to future community pumping. The PWCC groundwater flow model simulates the monitored springs using the MODFLOW Streamflow Routing Package (SFR2). The other non-monitored springs are represented by drain cells.

As previously discussed in the assessment of direct impacts on springs, the model simulated zero flow at the Moenkopi School and Burro Spring sites throughout the simulated period (1956-2110). This is thought to be due to complexities in the local geologic environment and the limitation of vertical discretization to simulate these complexities at these locations (Tetra Tech 2014, Tetra Tech 2015b).

Simulated cumulative effects on flow at the other two spring locations between 2019 and 2110 are given in **Table 3.7-30**.

Table 3.7-30 PWCC Model Simulated Spring Flow Cumulative Pumping Effects 2019 compared to 2110

Spring Name	2019 Simulated Flow (gpm)	2110 Simulated Flow (gpm)	% Change
Pasture Canyon	117	33.4	-71
Unnamed near Dennehotso	3.5	3.5	0

The change (reduction) in spring flow at Pasture Canyon is due to its proximity to Tuba City water supply wells. As noted in the direct impact section, no change in spring flow at the USGS monitored springs is predicted due to PWCC pumping under the Proposed Action. Changes in groundwater levels and discharge in the Pasture Canyon/Tuba City area are dominated by community pumping. The projected municipal pumpage at Tuba City ranges from 1,109 acre-feet per year in 2019 to 4,751 acre-feet per year in 2110, a fourfold increase. At Dennehotso, the percentage pumpage increase is greater than at Tuba City, but the 2110 volume is much smaller (1,207 acre-feet per year) and the pumping is further away from the spring. No change in flow at the Unnamed spring near Dennehotso is predicted due to combined PWCC and community pumpage. As noted in the assessment of direct impacts on springs, no change in flow at any of the USGS monitored springs is predicted as a result of the Proposed Action mine pumping under either the 3-Unit Operation or 2-Unit Operation. Thus, the impact to monitored springs is predicted to result from cumulative increases in community pumping over time. These cumulative impacts would range from none (Unnamed Spring near Dennehotso) to severe (Pasture Canyon), depending on withdrawal rates at N-Aquifer community pumping wells and their proximity and hydrologic connection to springs.

Due to model limitations, only 3 of the 98 simulated non-monitored springs produced a flow rate. The three flowing springs showed a decline in flow of 0.01, 0.02, and 3.48 gpm, respectively, between 1956 and 2110 due to combined Proposed Action and community pumping. The largest decline is at a spring located in Group D (see **Figure 3.7-14** presented previously), near the area of the Tuba City production wells, and represents a 60 percent decline (a severe impact). The other two springs are in Groups I and F1 and constitute a decline in flow of 1.5 and 3.0 percent, which are negligible impacts.

Since spring flow is proportional to change in head, to evaluate any potential change at the locations where the model predicted zero spring flow, the change in head (drawdown) due to Proposed Action and community pumping was noted. Model-predicted change in head at the simulated springs with zero flow ranged from zero to a maximum of approximately -39 feet; the median change is approximately -0.4 feet over the modeled period. These could create none to major cumulative impacts, depending on the spring location. The maximum predicted cumulative change-in-head impact would be in the Pasture Canyon area due to community pumping. This would be a major impact. The largest predicted impact from proposed PWCC pumping would be a head decline of 0.23 feet in the Blue Canyon area on Moenkopi Wash. This would be a negligible impact. Small cumulative drawdowns in the Shonto area (**Figure 3.7-16**) would likely create negligible spring impacts there.

The USGS regularly monitors flow at Moenkopi School Spring/Susunova Spring with a baseflow of approximately 10 to 20 gpm, or about 0.3 to 0.35 cfs. The model does not produce simulated flow at Moenkopi School Spring. The USGS describes the spring as "3GS-77-6, Navajo Sandstone tongue in Kayenta Formation" implying that locally the Navajo Sandstone connects to the spring within the Kayenta Formation (Littin 1992). As noted in the modeling report, in the model the Navajo is not present at the location, and the hydrogeologic characteristics of the Kayenta Formation are significantly different enough to make simulation of the observed flow rates impossible to match. The model represents the

Navajo Sandstone and the Kayenta Formation each as a single numerical model layer. This means that simulation of perched water, or water flowing in an isolated subunit is not possible to perform, as this would require subdivision of a model layer into at least 2 and probably 3 sub-layers. Spring discharge is expected to be directly tied to groundwater level at this location. A decrease in water levels would tend to cause a corresponding decrease in discharge at the spring. Although the model does not provide the ability to simulate flow at the location of the spring, simulated water levels in model layers 5 and 6 where these layers are active are likely to provide appropriate surrogate water level data for the purpose of evaluating the effects of pumping.

Between 1970 and 2012, the observed static water level elevation at Tuba City well NTUA1 (2.5 miles north) has declined by approximately 40 feet. Over the same time period, the model predicts a corresponding 53 feet of drawdown at the same well. All of this drawdown is due to local community pumping. Observed decreases in flow at the spring also are believed to be due exclusively to the drawdown associated with community pumping. In contrast, mine-related pumping effects at Tuba City N1 are simulated to be <0.01 feet in 2057 and 2110. Also, at the model cell associated with Moenkopi School Spring (model layer 6), mine-related pumping effects are simulated to be negligible (< 0.01 feet) by 2057 and 2110.

The USGS-observed baseflow from Burro Spring is approximately 0.2 to 0.4 gpm, or about 0.0004 to 0.0009 cfs. The location of Burro Spring is approximately 1,000 feet southeast of the Oraibi Wash channel, and approximately 75 to 100 feet higher in elevation. In aerial photos of the adjacent Oraibi Wash channel, the channel appears dry with some vegetation, suggesting that groundwater is likely present in the shallow alluvium of the channel. This means that flow occurring at Burro Spring is likely due to groundwater being locally perched on a layer within the Navajo Sandstone. As noted in the modeling report and for the reasons mentioned above, this condition is not possible to simulate within the framework of the model structure since the Navajo Sandstone is represented by a single numerical layer. Simulated drawdown at the model cell should represent an effective means of predicting spring discharge impacts at the location due to pumping, assuming that the water flow to the spring is directly linked to the regional N-Aquifer, and not solely a product of local recharge. No simulated drawdown occurs at the location of Burro Spring by 2057. By 2110, 0.09 feet of drawdown is simulated at the location of the spring, all of which is due to community pumping.

- Scoping Concern: Baseflow reductions along streams could occur from the combination of Proposed Action mine-related pumping and community groundwater pumping of the N-Aquifer.

Impacts of Combined Mine-Related and Community Pumping on Stream Baseflows, 3-Unit Operation	Impacts of Combined Mine-Related and Community Pumping on Stream Baseflows, 2-Unit Operation
Negligible mine-related baseflow impacts are predicted. Negligible to severe cumulative baseflow impacts are predicted, with the greatest estimated reductions along Chinle Creek, Laguna Creek, Polacca Wash, and Begashibito Wash.	Potential impacts would be the same as those described for the 3-Unit Operation.

As noted previously, the impact of proposed pumping at the proposed KMC on stream baseflow is assessed by a numerical model of Black Mesa prepared for PWCC by Tetra Tech, Inc. Baseflows are supported by groundwater discharge, and are important to the length of time that there is water in a channel during dry periods. The model was calibrated by simulating measured water levels and stream and spring flow from 1956 through 2012. Stream baseflow at eight locations is simulated using the MODFLOW Streamflow Routing Package (SFR2). The model has been reviewed by the USGS and determined to be suitable for use in predicting stream baseflow change within the model domain. Details of the model, the USGS review and model files are presented in **Appendices WR-9** and **WR-10**.

Simulated stream baseflow locations are shown on **Figure 3.7-13**. Simulated baseflow at the seven model locations were presented previously in **Table 3.7-17** for 1956 (pre-PWCC pumping) and 2019 (with PWCC pumping). As discussed previously, while the Proposed Action mine-related pumping stops in 2057, community pumping continues at a compounding annual rate indefinitely. In the model, community pumping is projected into the future through 2110. The increase in annual withdrawal by community wells in 2110 is nearly six times their estimated 2019 annual pumping rate.

The impact of all proposed mine-related pumping, windmill, and anticipated community withdrawals on simulated stream baseflow at the monitored stream gage locations between 1956 and 2019 was presented previously in **Table 3.7-17**. **Table 3.7-31** below presents additional information, showing the different components of pumping and their predicted effects on channel baseflows. For the Year 2110, the table identifies the anticipated effects of the mine-related Proposed Action pumping, projected community effects without mine-related pumping (i.e., the No Action), and also the anticipated cumulative effects of combined mine-related and projected community pumping (i.e., "All Pumping").

Table 3.7-31 Simulated Baseflow End of 2019 Compared to 2110 Cumulative Pumping Effects (Combined Community and Proposed PWCC Pumping)

				Cumulative (Combined) Effects		Community Pumping Only (No Action)		Proposed Action Only	
Location[1]	USGS Station No.	End of 2019 (cfs)	2110 (cfs)	Difference (cfs)	Percent Change from Year 2019[2]	Difference (cfs)	Percent Change from Year 2019[2]	Difference (cfs)	Percent Change from Year 2019[2]
Moenkopi Wash	09401260	1.637	1.626	-0.011	-0.68	-0.0108	-0.66	-0.0004	-0.023
Dinnebito Wash	09401110	0.200	0.200	0.000	-0.06	-0.0001	-0.05	-0.0000	-0.012
Polacca Wash	09400568	0.098	0.067	-0. 031	-32.1	-0.0308	-31.4	-0.0007	-0.713
Chinle Creek	09379200	0.309	0.161	-0.147	-47.7	-0.1447	-46.8	-0.0027	-0.87
Jeddito Wash	09400583	0.062	0.061	-0.001	-2.05	-0.0012	-2.01	0.0000	-0.045
Begashibito Wash	NA	0.101	0.083	-0.018	-18.3	-0.0185	-18.3	0.0000	-0.030
Laguna Creek	09379180	0.326	0.186	-0.140	-43.0	-0.1375	-42.2	-0.0027	-0.827

[1] Locations are indicated on **Figure 3.7-13**.

[2] Arithmetic rounding effects: values shown reflect more decimal places available in the model outputs than are shown here for flow rate differences

cfs = flow rates in cubic feet per second.

NA – Not Applicable – No USGS gage at this location.

Source: Tetra Tech 2016.

The difference between the table values results from simulating all anticipated N-Aquifer pumping (PWCC, windmill, and community) from 2020 through 2110. Simulated total estimated withdrawal over this period is 1,002,983 acre-feet.

Over the same period, total PWCC 3-Unit Operation pumpage is predicted to be 32,500 acre-feet, or 3.2 percent of the total cumulative pumpage. As a result of the relatively small projected total withdrawal due to Proposed Action pumpage, negligible changes in 2110 stream baseflow due to mine-related pumping (3-Unit Operation or 2-Unit Operation) are predicted by the PWCC model. The majority of pumping effects on stream baseflows result from anticipated future community N-Aquifer pumping. The major baseflow declines due to non-project (primarily community) pumping effects and occur at Chinle Creek (46.8 percent), Laguna Creek (42.2 percent), Polacca Wash (31.4 percent), and Begashibito Wash (18.3 percent). These impacts would be major; impacts would be none to negligible at other locations.

- Scoping Concern: Cumulative proposed PWCC withdrawals combined with anticipated community pumping could reduce N-Aquifer water quality by increasing D-Aquifer leakage across the Carmel Formation.

Impacts of Combined Mine-Related and Community Pumping on Springs, 3-Unit Operation	Impacts of Combined Mine-Related and Community Pumping on Springs, 2-Unit Operation
Negligible cumulative effects on N-Aquifer water quality would result from combined pumping.	Potential impacts would be the same as those described for the 3-Unit Operation.

The potential for reduced N-Aquifer water quality (i.e., sulfate concentrations) in the N-Aquifer from cumulative pumping withdrawals also was analyzed for the EIS by simulation using the groundwater model. Results are presented in **Table 3.7-32** below. In general, there is little cumulative effect. The greatest potential impact is well east of the coal leasehold, south of Rough Rock in the Cottonwood locale just west of Chinle Wash. As can be seen by comparison with **Table 3.7-16**, these cumulative effects do not result from proposed mine-related activities. Based on these results, negligible cumulative effects on N-Aquifer water quality would result from combined pumping.

Table 3.7-32 Predicted Sulfate Concentration and Percentage Change due to All Combined Pumping (Community and Mine-Related) through 2110

Subarea	Initial Concentration (mg/L)		Predicted Final Concentration (mg/L)	Navajo Sandstone (% Change)
	D-Aquifer	Navajo Sandstone	Navajo Sandstone	
Northeast	250	70	71.095	1.5643
East	850	100	117.734	17.7340
Hopi Buttes	360	50	51.888	3.7760
Forest Lake	1,000	100	100.354	0.3543
Kits'illie	75	30	30.025	0.0838
Pinon	200	5	5.150	2.9954
Rocky Ridge	250	10	10.159	1.5879
Preston Mesa	400	10	10.000	0.0017
Leasehold	400	30	30.079	0.2631
Pinon to Kits'illie	1,000	20	20.571	2.8573
Surrounding Leasehold	100	45	4.5015	0.0322
Red Lake to Tuba City	400	50	50.154	0.3075
Hotevilla to Kabeto	200	35	35.358	1.0229
Pinon to Rocky Ridge	210	140	140.083	0.0590

Source: Tetra Tech 2015a.

3.7.4.2.5.4 Past Effects on Wepo Formation Water Levels, Water Quality, and Uses

- Scoping Concern: Long-term mining activities have reduced water levels and water quality in the Wepo Formation.

Impacts of Combined Mine-Related and Community Pumping on Springs, 3-Unit Operation	Impacts of Combined Mine-Related and Community Pumping on Springs, 2-Unit Operation
Long-term effects on Wepo aquifer water levels have varied in relation to the configurations of local water-bearing zones and hydraulic gradients with respect to those of mine pits and topography. These impacts are limited in extent, and would only affect some wells in or near the leasehold. Impacts of water quality changes have been negligible within the coal resource areas. Elsewhere on Black Mesa, springs and wells supplied from the Wepo Formation have not been affected by mining activities.	Impacts have not differed from the 3-Unit Operation.

Limited interception of Wepo Formation groundwater has already occurred during PWCC mining at existing coal resource areas (OSMRE 2011a). Long-term groundwater levels in Wepo Formation monitoring wells display a mix of rises and declines. Most of the wells in the northwest part of the leasehold, where mining activity has been extensive, have declined over time. Similarly, in the eastern part of the leasehold, water levels at WEPO62R near the J16 mined area have declined. In contrast, levels in monitoring wells WEPO44, 49, 54, and 59 along Moenkopi Wash have remained within their baseline ranges or have risen. Wepo aquifer water levels in the J19/J21 coal resource vicinity display a mix of declines (at WEPO65, 68) and fairly steady levels (at WEPO 66, 67). Although nearby pits drain groundwater from higher elevations, it appears that relatively porous pit backfills generally have not contributed to increasing downgradient water levels in tighter, consolidated formation rocks.

As described in the Affected Environment section and **Appendix WR-5**, the Wepo Formation consists of various rock types that formed from a variety of depositional environments. These individual zones have limited local extent, and form perched, or isolated water bearing zones. Many of these zones are pressurized. Groundwater elevation contours and gradients generally follow significant surface topography. As discussed previously, major washes and canyons intersect the formation and further hydraulically isolate one part of the formation from another.

Long-term effects on Wepo aquifer water levels have varied in relation to the configurations of local water-bearing zones and hydraulic gradients with respect to those of mine pits and topography. This would continue under a Proposed Action option. Given the geologic nature of the formation, cumulative water level declines in the Wepo Formation could not extend more than 3 to 5 miles beyond a mine pit. Given the dissected topography of Black Mesa, it is unlikely that detectable drawdown effects could extend more than a mile or so outside the leasehold. In some cases, this may have created drawdown within water-bearing zones beyond the leasehold. However, most drawdown effects in the Wepo Formation are probably much less extensive. Particularly from upgradient areas northeast of the leasehold, the overall flow direction is to the southwest towards the mining activities. As a result, cumulative drawdown probably has been less extensive to the northeast. Springs or wells that are sourced from the Wepo Formation beyond about 3 to 5 miles from the leasehold, or from isolated upgradient positions closer in, have not been affected by mining activities.

Yellow Water Canyon Wash, Coal Mine Wash, Moenkopi Wash, and Dinnebito Wash all intersect the Wepo Formation and allow it to drain to surface water and alluvial deposits. Dinnebito Wash in particular restricts cumulative drawdown effects from extending further east. Elsewhere on Black Mesa, springs and wells supplied from the Wepo Formation have not been affected by mining activities. These outlying springs and wells have their sources in local, isolated Wepo Formation water-bearing zones, or are supplied from the Toreva Formation. The Toreva Formation is below the zone being mined by PWCC and is not affected by mining activity. These conditions would continue to apply to Wepo and Toreva formation groundwater resources if a Proposed Action option was implemented.

Long-term water quality characteristics of Wepo Formation monitoring wells are summarized in **Appendix WR-5**, **Tables WR-5.8** through **WR-5.12**. Trace element constituents had fairly low values in background wells as indicated in **Appendix WR-5, Table WR-5.8**. Dissolved lead had some presence, but typical values are below the surface water criterion for livestock watering. TDS concentrations were reasonable for the geologic conditions; there was a relatively low proportion of sulfate and relatively higher proportions of bicarbonate and sodium.

In the northwest part of the leasehold (**Appendix WR-5, Table WR-5.9**), most trace elements remained undetected or at low values in Wepo monitoring wells. Lead concentrations were elevated above those of background wells, and occasionally exceeded the surface water criterion for livestock watering. Typical lead concentrations were below the criterion, however. Sulfate was elevated above background conditions, as were bicarbonate, calcium, and magnesium. In general, these contributed to higher TDS values. Typical sulfate and TDS values remained within surface water criteria for livestock watering.

Elsewhere, groundwater quality conditions generally similar to these also are reflected in summaries for the northeast/east central part of the leasehold (**Appendix WR-5, Table WR-5.10**) and the former Black Mesa Mine area (**Appendix WR-5, Table WR-5.12**). Sodium and selenium concentrations were greater in Wepo monitoring wells in the former Black Mesa Mine area. On average, detected selenium concentrations exceeded the surface water criterion for livestock watering there, but most values were below the criterion. Selenium was detected in only 7 percent of Wepo Formation samples in the former Black Mesa Mine Area.

Historical water quality reductions from long-term mining activities have occurred, but concentrations have generally remained within livestock watering criteria or recommended values. Some springs or seeps issuing from the Wepo Formation downgradient of mining activities may have become more mineralized, but remain within background water quality ranges at springs within the leasehold. Existing Wepo aquifer groundwater quality typically continues to support aquatic and wildlife uses at springs.

Impacts of these changes have been negligible within these coal resource areas. Groundwater from Wepo aquifer wells has generally remained within livestock watering criteria or recommended values. Some springs or seeps issuing from the Wepo Formation downgradient of proposed mining activities may have become more mineralized, but remains within background spring water quality ranges. Future Wepo aquifer groundwater quality would provide aquatic and wildlife uses at springs, and permanent ponds and impoundments would provide other habitat. Based on the geography of these sampling results, the past extent of reduced groundwater quality in the locale was likely limited to part of the leasehold west of Dinnebito Wash and a short distance downstream. The extent of past mining is relatively small in the Dinnebito Wash watershed, and a substantial amount of undisturbed Wepo Aquifer remains in and around the leasehold. The uses of Wepo aquifer groundwater in this vicinity have been infrequent and are likely to remain so. These factors limit the extent of historical cumulative impact to a comparatively small area with little use of groundwater. Because of this, impacts would be negligible.

Over time, the establishment of permanent ponds and impoundments by PWCC has mitigated adverse impacts on local uses of Wepo Aquifer groundwater for habitat or livestock along Dinnebito Wash. These impacts and their mitigation would continue under either the 3-Unit Operation or the 2-Unit Operation.

3.7.4.2.5.5 Cumulative Effects on Alluvial Water Levels, Water Quality, and Uses

- Scoping Concern: In the past, historic mining activities have reduced alluvial groundwater levels in and near the leasehold. Alluvial groundwater availability has been reduced for other uses downstream on Black Mesa in the past, and the Proposed Action would add to these impacts in the future.

Impacts of Combined Mine-Related and Community Pumping on Springs, 3-Unit Operation	Impacts of Combined Mine-Related and Community Pumping on Springs, 2-Unit Operation
Mixed rises and declines in alluvial water levels have occurred within the leasehold over time. Generally these are negligible effects. Based on comparisons to early data at sites away from mining activities, drier climate conditions have had a substantial role in alluvial water level declines.	Potential impacts would be the same as those described for the 3-Unit Operation.

Alluvial groundwater levels are characterized over time in **Appendix WR-4**, **Table WR-4.1**. Only one alluvial well, ALUV87, has strictly baseline water level data, but several others have data from early periods that overlap baseline conditions and initial mining activities. Monitoring site ALUV87 is on the mainstem of Moenkopi Wash, well upstream of mining activities (**Appendix WR-1, Figure WR-1.1**). It is located in the east-central corner of the leasehold, 1 mile or more upstream of any mining activity.

Water levels in ALUV87 have been gradually declining since the early 1980s, most likely in response to the drier climatic period described in the Affected Environment. During the baseline period water levels ranged from 14.2 to 22.5 feet bgs. Since 2010, water levels have stayed in the lower part of that range (generally below about 20 feet) or slightly deeper. In 2014, the water level in ALUV87 was 23.7 feet bgs (**Appendix WR-4, Table WR-4.1**). The general pattern of deepening alluvial water levels also can be seen in ALUV108R. ALUV108R is on Dinnebito Wash upstream of mining activities. Although it does not have data from the early baseline period, since 2010 its water level has dropped between 3.3 and 5 feet below its deepest value during the late 1980s/early 1990s. Closer to likely mining effects, some of the alluvial wells with relatively early water level data have experienced recent declines of about 0.8 foot (ALUV72) to 5.4 feet (ALUV19) from the 1980s. The maximum decline has been 9 feet (ALUV93). In contrast, other alluvial water levels that are likely subject to mining effects have risen from their lowest early levels, such as at ALUV29 (5 feet) and ALUV83 (6 feet).

In summary, mixed rises and declines in alluvial water levels have occurred within the leasehold over time. Declines appear to dominate the water level changes; in general these are negligible effects. Based on comparisons to early data at sites away from mining activities, drier climate conditions have had a substantial role in water level declines.

As described for direct impacts, there are little or no existing uses of alluvial groundwater within the leasehold and nearby. The only other major use of alluvial groundwater is far downstream at Moenkopi, where withdrawals are used for agriculture. No effects to those uses would occur under a 3-Unit Operation or 2-Unit Operation. Alluvial groundwater levels much further downstream are affected by local precipitation and runoff there, as well as by local channel conditions and withdrawals. The downstream conditions reflect regional climatic changes, the thickness and types of materials comprising the channels, contributions from local aquifer discharges, and evapotranspiration. No regional effects from mining have or would occur to alluvial groundwater levels at distances far downstream of the leasehold.

- Scoping Concern: Long-term mining activities have reduced regional alluvial water quality and limited uses of alluvial groundwater.

Impacts of Combined Mine-Related and Community Pumping on Springs, 3-Unit Operation	Impacts of Combined Mine-Related and Community Pumping on Springs, 2-Unit Operation
Both upstream and downstream concentrations of TDS and sulfate exceed concentrations recommended in literature for livestock. Some alluvial groundwater quality impacts would occur across the leasehold, but constituents would still generally reflect the background geologic setting. These would be minor impacts. For most trace elements, cumulative impacts to alluvial groundwater quality would not occur.	Potential impacts would be the same as those described for the 3-Unit Operation

Alluvial groundwater quality declines from upstream to downstream across the leasehold as indicated in long-term monitoring data summaries (**Appendix WR-4**, **Tables WR-4.9** through **WR-4.12**). Dissolved trace element concentrations are typically low, and many are below detection limits in most samples. For example, dissolved arsenic was not detected in 83 out of 86 samples (96 percent) upstream on Moenkopi Wash (**Appendix WR-4, Table WR-4.11**). For most trace elements, cumulative impacts to alluvial groundwater quality would not occur.

In upstream to downstream comparisons of long-term data for Moenkopi Wash, mercury, arsenic, and other trace element values remained low across the leasehold (**Appendix WR-4, Tables WR-4.11** and **WR-4.12**). Vanadium concentrations declined. In contrast, selenium concentrations increased downstream, as did typical TDS values. Typical sulfate values also increased somewhat downstream. On Dinnebito Wash, most trace elements were undetected or had very low concentrations over the long term (**Appendix WR-4, Tables WR-4.9** and **WR-4.10**). Selenium was detected more frequently and at higher concentrations in downstream samples, but still remained well below the livestock watering criterion. Dissolved lead values increased downstream, and exceeded the livestock watering criterion at least once. However, lead was only detected in 4 out of 64 long-term samples downstream (6 percent). Similar to Moenkopi Wash comparisons, typical TDS and sulfate values increased downstream on Dinnebito Wash. These changes are depicted further in **Table 3.7-33** below.

Tables in **Appendix WR-4** show that both upstream and downstream concentrations of TDS and sulfate exceed concentrations recommended in literature for livestock watering (Raisbeck et al. 2008; Sigler and Kleehammer 2013).

Table 3.7-33 Major Water Quality Changes in Long-term Alluvial Groundwater Monitoring

Drainage within Leasehold	Median TDS Values, Upstream / Downstream (mg/L)	Median TDS Values, Upstream to Downstream (Percent Change)	Median Sulfate Values, Upstream / Downstream (mg/L)	Median Sulfate Values, Upstream to Downstream (Percent Change)
Moenkopi Wash	3,125 / 4,154	33	1,885 / 2,586	37
Dinnebito Wash	4,350 / 6,409	47	2,800 / 3,900	39

With respect to long-term (past) impacts in and near the leasehold, however, livestock watering from alluvial groundwater is uncommon and PWCC has historically mitigated potential losses of this use with additional ponds and impoundments. Substantial additional downstream watershed areas on both Moenkopi Wash and Dinnebito Wash reduce the regional influence of mining activities to none or negligible levels, well upstream of irrigated agriculture or other significant uses. Cumulative impacts from reduced alluvial groundwater quality would not occur from either the 3-Unit Operation or 2-Unit Operation.

3.7.4.2.5.6 Past Impacts to Shallow Springs and Seeps

- Scoping Concern: Historic mining activities have reduced flows at springs and seeps issuing from the alluvium or the Wepo Formation on Black Mesa in the past, and the Proposed Action would add to these impacts.

Impacts of Combined Mine-Related and Community Pumping on Springs, 3-Unit Operation	Impacts of Combined Mine-Related and Community Pumping on Springs, 2-Unit Operation
None to negligible long-term mining effects to alluvial or Wepo Formation springs have occurred outside the leasehold. PWCC has mitigated impacts to springs and seeps by replacing them on the leasehold by permanent ponds and impoundments	Potential impacts would be the same as those described for the 3-Unit Operation.

Relatively shallow springs and seeps are those from the Wepo Formation or, to a more limited degree, alluvial deposits in and along streams. Impacts to shallow springs and seeps from mining activities have been limited to within the leasehold, or at most within a mile or so downgradient of its boundaries. These impacts are described further in groundwater assessments for the alluvium and the Wepo Formation below. More extensive impacts to shallow springs and seeps would not occur.

PWCC has mitigated impacts to springs and seeps by replacing them on the leasehold by permanent ponds and impoundments. These structures typically provide better water availability and water quality. Elsewhere on Black Mesa, springs and wells supplied from the Wepo Formation have not been affected by mining activities. These outlying springs and wells have their sources in local, isolated Wepo Formation water-bearing zones (**Appendix WR-5**), or are otherwise supplied from the Toreva Formation. The Toreva Formation is below the zone being mined by PWCC and is not affected by mining activity.

3.7.4.2.5.7 Potential Cumulative Impacts to Surface Flows on Moenkopi Wash or Dinnebito Wash

- Scoping Concern: In the past, stream runoff and baseflows retained in ponds and impoundments on the coal leasehold may have reduced the availability of surface water for other users at locations far downstream, and the Proposed Action could continue to do so in the future.

Impacts of Combined Mine-Related and Outlying Retention on Streamflows, 3-Unit Operation	Impacts of Combined Mine-Related and Outlying Retention on Streamflows, 2-Unit Operation
Downstream channel flow impacts (reductions) from water retention in the coal leasehold would not occur. Impacts to channel flows from outlying structures or activities would be none to moderate, depending on location and nature of the diversions.	Potential impacts would be the same as those described for the 3-Unit Operation.

As identified during scoping meetings, there are concerns that expansion of mining areas under either the 3-Unit Operation or 2-Unit Operation have the potential to reduce flows needed for other uses (agriculture, livestock watering) at downstream locations along Moenkopi Wash or Dinnebito Wash. This potential exists because water resulting from runoff, purge water from well testing, and pit pumping has been and would be retained in ponds and impoundments to control the water quality of disturbed area discharges. These management practices are conducted by PWCC in response to USEPA and OSMRE regulatory programs. By retaining surface flows in the mine area, there are concerns that downstream uses along Moenkopi Wash and Dinnebito Wash have been and could be impacted by reduced water volumes. These designated uses include agricultural irrigation, aquatic and wildlife habitat, livestock watering, full body contact, partial body contact, and groundwater recharge (**Appendix WR-1**). Given that these uses occur in different locations along the lower washes, they also are affected by other retention or withdrawals at different locations along Moenkopi and Dinnebito washes.

Because of numerous non-mining runoff controls on Dinnebito Wash, and interactions between surface water, alluvial sands, and irrigation sumps on lower Moenkopi Wash, the potential for these structures and activities to interact with mine-related effects on the lower washes has been reviewed as part of cumulative water controls and uses. These combined factors, in conjunction with natural background conditions (e.g., evapotranspiration, channel seepage), are reflected in flow records at the identified streamgages on the lower washes. The proportions of these factors cannot be quantified with available information, but downstream structures and activities outside the leasehold do have an effect on flows at the gages.

There are at least 20 diversion or retention structures along Dinnebito Wash outside of the leasehold. These non-mining uses (runoff diversions, pond storage) also have the potential to affect downstream flows, e.g., at the USGS streamgage near Sand Springs (USGS 09401110). In addition, scoping inputs reflect concerns at the Village of Moenkopi, where conditions can be represented by the USGS streamgage there (USGS 09401260). Hand-dug pits are used for agricultural diversion sumps in the channel alluvium in that locale.

In the arid setting, most of the runoff from the leasehold does not contribute to flow at the USGS gages or to designated uses further downstream, due to channel transmission losses and evapotranspiration along the way. In addition, baseflows are provided by the Toreva Formation and other geologic units that are not affected by mining. Notably, approximately 70 miles of meandering sand channel extend across the arid landscape from the leasehold to the first occurrence of irrigated agriculture near the community of Moenkopi. At the downstream edge of the leasehold, PWCC gages monitor about 253 square miles of watershed. The USGS gage downstream at the community of Moenkopi monitors about 1,629 square miles. Based on contemporaneous monitoring at leasehold stations on Moenkopi Wash, and the USGS stream gage at Moenkopi, PWCC has demonstrated substantial channel losses between the two locations. Even when assuming that no lateral inflows would have occurred between the monitoring sites, PWCC estimates that approximately 50 percent or more of the runoff from the leasehold can be lost in transit to the USGS gage; in some cases, much more seeped into the channel. This is a very conservative (low) assumption, since lateral inflows do occur due to the occurrence of rainfall between the stations during large storms.

Due to losses of runoff in transit and the substantial variability of precipitation across the watersheds, little or no impacts from PWCC retention structures occur to existing uses at Moenkopi. A similar assessment applies along Dinnebito Wash to Sand Springs, where the downstream leasehold gages monitor about 51 square miles of watershed, and the USGS gage monitors about 473 square miles. Because of these considerations, no mine-related cumulative impacts on downstream surface water runoff, baseflows, or uses would occur. Depending on the nature and location of a downstream structure or activity, effects from non-mining features further downstream are likely to have none to moderate effects on stream flows.

3.7.4.2.5.8 Potential Cumulative Impacts to Surface Water Quality

- Scoping Concern: In the past, reduced surface water quality flowing from the coal leasehold may have adversely impacted downstream uses and conditions, and these impacts would continue under the Proposed Action.

Impacts of Mine-related Water Quality Effects on Downstream Uses, 3-Unit Operation	Impacts of Mine-related Water Quality Effects on Downstream Uses, 2-Unit Operation
Due to natural background conditions and extensive downstream contributing watersheds, distant water quality impacts from the leasehold drainage area have been and would be none to negligible.	Potential impacts would be the same as those described for the 3-Unit Operation.

High rates of erosion and sediment transport are typical of the region, as mentioned in the Affected Environment. Sediment yields were previously modeled by PWCC using the SEDIMOT II application, which in its various forms has been an approved pond design tool for several decades. Subsequent reclamation planning and design efforts have used the EASI model (PWCC 2012 et seq.). PWCC siltation structures and other retention designs meet or exceed applicable requirements. Comparing the pre-mining estimates to the post-mining, reclaimed estimates indicates that at final reclamation, sediment yields from disturbed areas should be slightly less than the original condition (PWCC 2012 et seq.). Other Best Management Practices for runoff and wastewater control and drainage are employed at the proposed KMC in accordance with NPDES permit provisions. Based on ongoing application of approved structural and non-structural management practices, and additional programs implemented by PWCC in response to USEPA involvement, no cumulative impacts from accelerated sediment yields outside of the leasehold would occur with either the 3-Unit Operation or 2-Unit Operation.

To further examine conditions over past historical periods, additional long-term surface water quality characterizations were completed for both Moenkopi Wash and Dinnebito Wash, upstream and downstream of PWCC coal resource areas. Data from 1985 through 2005 were used on Dinnebito Wash, and data from 1981 to 2008 were used on Moenkopi Wash. On both washes, these efforts reviewed sampling events that were reasonably matched together with respect to upstream and downstream sample timing. Data results are summarized in **Appendix WR-1, Tables WR-1.17** through **WR-1.20**, and discussed further below.

On Moenkopi Wash, the following qualitative long-term (1981 through 2008) concentration changes from upstream to downstream are summarized from the surface water quality data review. While the constituents listed in **Table 3.7-34** do not comprise the entire suite of laboratory analyses, they include the ones of most interest with respect to existing designated uses.

Table 3.7-34 Moenkopi Wash Long-term Water Quality Comparisons, Upstream to Downstream within the Leasehold

Constituent [1]	Percent Non-Detected, Downstream	Qualitative Change toward Downstream, Remaining Detected Values [2]	Constituent [1]	Percent Non-Detected, Downstream	Qualitative Change toward Downstream, Remaining Detected Values [2]
Aluminum (t)	6.2	Little or None	Iron (t)	5.4	Decrease
Arsenic (t)	25	Increase	Lead (t)	34	Decrease
Arsenic (d)	73	Decrease	Lead (d)	90	Increase
Cadmium (t)	73	Mixed	Mercury (t)	72	Slight Increase
Cadmium (d)	92	Increase	Selenium (t)	50	Slight Decrease

Table 3.7-34 Moenkopi Wash Long-term Water Quality Comparisons, Upstream to Downstream within the Leasehold

Constituent [1]	Percent Non-Detected, Downstream	Qualitative Change toward Downstream, Remaining Detected Values [2]	Constituent [1]	Percent Non-Detected, Downstream	Qualitative Change toward Downstream, Remaining Detected Values [2]
Chromium (t)	28	Slight Increase	TDS	0	Large Increase
Chromium (d)	98	Increase	TSS	3.9	Large Decrease
Copper (t)	15.6	Little or None	Sulfate	0	Large Increase
Copper (d)	80	Decrease	Vanadium (t)	11	Little or none

[1] Reference **Appendix WR-1**, **Tables WR-1.17** and **WR-1.18**.

[2] Qualitative descriptions of changes are based on comparing average and median values, as changes from upstream to downstream.

t = total.

d = dissolved.

While these are qualitative conclusions, in general there was fairly consistent long-term trace element chemistry from upstream to downstream along Moenkopi Wash across the leasehold. While some total constituent values increased, their dissolved fractions decreased or a large portion of the analyses were below detection limits. In some cases ("Mixed"), the changes between average concentrations differed from the changes in median concentrations. Although detected values in some constituents increased downstream (e.g., lead), these constituents were not detected in large percentages of the long-term sampling results. The most notable impacts from data presented in the summary tables in **Appendix WR-1** are substantial long-term increases in typical TDS and sulfate values in the downstream direction, and a substantial decrease in long-term TSS downstream. The latter effect is likely due to PWCC water management practices, and would generally be considered an ongoing beneficial impact. Increases in TDS and sulfate concentrations were likely caused by a combination of mine water management and some background contributions, and would be an ongoing localized impact within the leasehold as described for direct impacts. Although the TDS and sulfate values increased downstream, their typical concentrations remained within recommended livestock watering values (Raisbeck et al. 2008; Sigler and Kleehammer 2013) and are likely to continue to support that use. Sulfate and TDS criteria for aquatic and wildlife uses were met by median concentrations upstream, but were exceeded by median concentrations downstream. Since these would be localized impacts, and background conditions elsewhere on the mesa are generally similar, mine-related impacts to overall watershed conditions would be none to negligible.

Downstream along Moenkopi Wash, all of these constituents have been and would be further contributed by lateral channel inflows and runoff from additional watershed areas that are not affected by mining. Surface water quality more than a few miles downstream of the leasehold reflect influences from local runoff and baseflows from nearby geologic sources. On much of Black Mesa, the latter primarily include the Wepo and Toreva formations, Mancos Shale, and the D-Aquifer formations (**Figure 3.7-4**). Historical USGS downstream sampling along Moenkopi Wash had typical sulfate values of 642 mg/L (mean) and 315 mg/L (median). TDS concentrations had average and median values of 1,147 and 680 mg/L, respectively. A Hopi Tribal sample at the Blue Canyon water caves in June 2009 had a sulfate concentration of 201 mg/L, and a TDS value of 550 mg/L. In August 2007, a tribal sample there had a sulfate result of 580 mg/L and a TDS value of 980 mg/L. These are not out of line with concentrations on Moenkopi Wash at the downstream side of the coal leasehold. There are 253 square miles in the leasehold drainage area for Moenkopi Wash, only part of which are affected (see **Table 3.7-22** for a general concept). Because of regional contributions from a far larger undisturbed watershed

(1,629 square miles at Moenkopi), more distant water quality impacts from the leasehold drainage area have been and would be none to negligible.

On Dinnebito Wash, the following qualitative long-term (1985 through 2005) concentration changes from upstream to downstream are summarized in **Table 3.7-35** from the surface water quality data review. Again, the constituents listed do not comprise the entire suite of laboratory analyses, but are of most interest in regard to designated uses.

Table 3.7-35 Dinnebito Wash Long-term Water Quality Comparisons, Upstream to Downstream within the Leasehold

Constituent [1]	Percent Non-Detected, Downstream	Qualitative Change toward Downstream, Remaining Detected Values [2]	Constituent [1]	Percent Non-Detected, Downstream	Qualitative Change toward Downstream, Remaining Detected Values [2]
Aluminum (t)	0	Increase	Iron (t)	0	Mixed
Arsenic (t)	4.5	Large Decrease	Lead (t)	32	Large Increase
Arsenic (d)	47	Little or None	Lead (d)	92	Large Increase
Cadmium (t)	73	Mixed	Mercury (t)	50	Large Increase
Cadmium (d)	100	Little or None	Selenium (t)	27	Decrease
Chromium (t)	9.1	Increase	TDS	0	Large Decrease
Chromium (d)	100	Little or None	TSS	0	Large Increase
Copper (t)	0	Mixed	Sulfate	0	Large Decrease
Copper (d)	93	Little or None	Vanadium (t)	0	Mixed

[1] Reference **Appendix WR-1**, **Tables WR-1.19** and **WR-1.20**.

[2] Qualitative descriptions of changes are based on comparing average and median values, as changes from upstream to downstream.

t = total.

d = dissolved.

Long-term surface water quality across the leasehold in Dinnebito Wash appears to behave differently than that in Moenkopi Wash. Some trace element concentrations typically did not increase or decrease substantially in a downstream direction. In some cases ("Mixed"), the changes between average concentrations differed from the changes in median concentrations. Along Dinnebito Wash, typical detected long-term lead concentrations were well above standards upstream above mining activities, and increase further downstream through the leasehold. Typical mercury values behaved similarly. However, both lead and mercury remained below detection limits in large portions of samples. Lead and mercury concentrations were not detected in 92 percent and 50 percent of long-term sampling results, respectively. Typical long-term vanadium concentrations exceeded standards upstream. They declined downstream, but still exceeded standards.

Typical long-term sulfate and TDS values declined downstream along Dinnebito Wash, whereas typical long-term TSS values increased. For TDS, sulfate, and TSS, these are opposite to the water quality effects on Moenkopi Wash. Similar to Moenkopi Wash conditions, however, livestock water uses are generally supported by typical TDS and sulfate values when compared to recommended values (Raisbeck et al. 2008; Sigler and Kleehammer 2013). Typical sulfate, TDS, and TSS values exceeded aquatic and wildlife habitat criteria both upstream of mining activity on Dinnebito Wash and downstream through the leasehold. Because of these results and the nature of upstream background surface water quality in the overall mesa area, mine-related impacts would be none to negligible. There are 51 square miles in the leasehold drainage area for Dinnebito Wash, only part of which are affected (see **Table 3.7-22** for a general concept). Background conditions in the larger watershed (e.g., 473 square miles at Sand Springs) would contribute water quality constituents to surface flows. Because of regional contributions, downstream water quality impacts from the leasehold drainage area have been and would be none to negligible.

3.7.4.2.5.9 Cumulative Impacts Along Transmission Lines

- Scoping Concern: Water quality in streams crossed by transmission lines could be reduced by construction or maintenance activities in the ROWs.

As previously described, no direct impacts to water resources would occur along either transmission system as a result of the Proposed Action or action alternatives; similarly, no cumulative impacts would occur. Existing operation and maintenance practices (**Appendix 1B**), agency ROW requirements, and any additional requirements that may stem from future ROW agency approval processes, would avoid or mitigate direct project impacts to water resources along the transmission systems. Therefore, there would be no cumulative or additive impacts associated with the transmission systems from the Proposed Action, an alternative, or No Action.

3.7.4.3 Natural Gas Partial Federal Replacement Alternative

This discussion is divided into two parts. The first part describes assumptions about the alternative electrical supply site and operational characteristics and primary water resources impacts that have occurred or would occur. The second part addresses the impacts to water resources from reducing the power generated at NGS, with consequent reductions in coal production at the Kayenta Mine.

Under the Natural Gas Partial Federal Replacement (PFR) Alternative, a selected quantity of power between 100 megawatts (MW) and 250 MW would be contracted for under a long-term power purchase agreement from currently unidentified, existing natural gas generation sources, displacing an equivalent amount of power from the federal share of NGS generation. Because the facility is unknown but assumed to currently exist, prior disturbance impacts to water resources are not evaluated. The following list presents key assumptions about water resources related to an existing natural gas-fueled, electrical power-generating plant. Based on these characteristics, future water resources impacts at such a site would be none to negligible. The following water management-related aspects of such a facility are listed below.

- A combined-cycle natural gas power plant would typically be located on a dry, upland site of approximately 100 acres. No additional surface disturbance would be required over time.
- Existing natural gas pipelines to the facility, and transmission lines from the facility would have been constructed, operated, and maintained in accordance with applicable agency ROW permit stipulations and construction storm water permit requirements (including a Storm Water Pollution Prevention Plan), federal floodplain requirements (Executive Order 11988/13690), and hydraulic considerations for channel scour and bank migration at stream crossings.
- An SPCC Plan has been implemented and maintained to prevent, or respond to and report, spills or leaks of petroleum products. Operations and maintenance activities are conducted in compliance with a current industrial NPDES permit, with attendant Storm Water Pollution Prevention Plan.
- All water used for potable or sanitary uses and for other operational uses (e.g., testing of valves or pipelines, dust suppression at the plant site and access roads, etc.) has been obtained through existing water rights. Any depletions have been approved and mitigated if necessary through applicable agency requirements and approvals.
- Only non-hazardous materials are disposed of in landfills on the site.

- Natural gas combustion to generate power would not result in deposition to surface water of the trace elements associated with coal combustion under the Proposed Action. This difference in emissions is addressed in Section 3.1.

Impact issues for this PFR alternative are discussed across the range of NGS unit operations (3-Unit and 2-Unit) and associated alternative power reductions (100 MW and 250 MW) from the least NGS power reduction to the greatest. Reductions in NGS power generation would proportionally reduce the quantity of coal delivered from the Kayenta Mine. The focus of this discussion is to distinguish differences in impacts within the operational range of the alternative to provide a basis for comparison with the Proposed Action.

3.7.4.3.1 Navajo Generating Station

The following topics discuss potential impacts water resources if 100 MW to 250 MW of power generation were replaced at NGS. Under this alternative, alternative power would be purchased from an unknown, but existing source of electrical power generated with natural gas. It should be noted that decommissioning and reclamation practices are summarized in **Appendix 1B** and its supplemental Groundwater Protection Plan. These are both included as part of the EIS. Importantly, the Groundwater Protection Plan addresses water resources monitoring and protection at the NGS in accordance with federal regulations. For the Proposed Action, for all alternatives, and for the No Action, discussions of particular NGS considerations (e.g., ash disposal, potential spills or leaks, decommissioning and post-closure monitoring) take into account the past, present and future activities that have been conducted and would be conducted by SRP at the plant. These are further documented in the Operations Groundwater Protection Plan, and would be continually developed and implemented in ongoing NGS programs.

3.7.4.3.1.1 Impacts to Surface Water or Groundwater Quantity or Quality from Dry Ash Disposal

Additional disposal of dry coal combustion products in the existing ash disposal area would not affect runoff volumes or water quality in the study area. The ash is deposited as a dry or nearly dry material in an arid environment. If an expanded ash disposal area were required, its acreage would be small (on the order of 40 acres or so) and would not affect surface water. Groundwater is not used at the plant or at the ash disposal site. Water in the N-Aquifer is hundreds of feet below the disposal area, and existing monitoring has shown no impacts from the facility. Ongoing groundwater monitoring would document and report any aquifer effects if they occurred. USEPA agency oversight continues, and regulatory actions would be implemented in the highly unlikely event that groundwater quality would be affected.

Closure and post-closure activities at the ash disposal landfill would be planned and implemented according to accepted professional engineering practices in accordance with the Groundwater Protection Plan and Coal Combustion Residuals Rule. As with the Proposed Action, additional runoff and run-on control features and other practices to protect water resources would be implemented in accordance with agency requirements. Groundwater monitoring and site inspections are part of existing site management by SRP. These would continue with under the Natural Gas PFR Alternative, in accordance with USEPA regulatory programs (Coal Combustion Residuals Rule) and the NGS-specific Groundwater Protection Plan. Additional descriptions of activities that would be planned, implemented, and monitored are presented in Appendices B and C of **Appendix 1B** and mentioned in the “No Action” discussion (Section 3.7.4.6 below).

With respect to water resources, the Groundwater Protection Plan developed in response to the CCR Rule would be the primary guidance document for water-related decommissioning work. Additional specific component planning, implementation, and monitoring would be completed by SRP, and would include coordination with appropriate agencies (e.g., USEPA, Navajo Nation authorities). Lease requirements and USEPA regulations at the time of closure would be used as the basis for specific implementation of plant decommissioning procedures and practices, including those at the ash disposal area. Because of these factors, no impacts to water resources at the dry ash disposal area would occur.

3.7.4.3.1.2 Impacts to Surface Water or Groundwater from Spills or Leaks at Fluid Storage or Evaporation Ponds

No water resources impacts would occur from uses of existing ponds under continued operations and maintenance, and agency-approved inspection and monitoring programs. If any new ponds are needed, impacts to water resources would be avoided by appropriate design and construction, monitoring, and maintenance. Under this alternative, NGS would continue to operate and maintain perched water monitoring and recovery to address leaks isolated under the plant area. No impacts to water quality in the N-Aquifer would occur.

Similar to the Proposed Action, water management under this alternative would include practices and procedures described in the Groundwater Protection Plan. These would include continued implementation of the Perched Water Dewatering Work Plan (**Appendix 1B**). Because of ongoing recovery and discharge of leaks to the plant process water stream, no impacts to the N-Aquifer would occur under this alternative.

Closure and post-closure activities for ponds would be planned and implemented according to accepted professional engineering practices. No water resources impacts would occur.

3.7.4.3.1.3 Effects of Water Withdrawals for NGS on Water Levels and Surface Area of Lake Powell

Estimated potential changes in water level and reservoir extent are indicated in **Table 3.7-36** below. Water use estimates are pro-rated (based on power generation and units operated) from the Proposed Action values.

Table 3.7-36 Estimated Direct Effects of Natural Gas PFR Water Withdrawals on Lake Powell

Typical Water Use[1]	Reservoir Status	Typical 100-MW PFR Annual Water Use (acre-feet per year)	Predicted 100-MW PFR Water Level Reduction (inches)	Predicted 100-MW PFR Lake Area Reduction (acres)	Typical 250-MW PFR Annual Water Use (acre-feet per year)	Predicted 250-MW PFR Water Level Reduction (inches)	Predicted 250-MW PFR Lake Area Reduction (acres)
NGS 3-Unit Operation	Normal Pool	27,840	2.1	131.4	25,230	1.9	119.1
	Extreme Drought	27,840	4.5	166.1	25,230	4.1	150.6
NGS 2-Unit Operation	Normal Pool	17.986	1.4	84.9	16,052	1.2	75.8
	Extreme Drought	17.986	2.9	107.3	16,052	2.6	95.8

[1] Tabulated values reflect arithmetic rounding differences and interpolation from existing Lake Powell data.

Source: Reclamation 2009, 2007.

As can be seen in the table above, differences between the Natural Gas PFR operating alternatives are not substantial in relation to the overall reservoir characteristics described in the Affected Environment. Differences from a respective Proposed Action effect at the listed reservoir condition (full pool or drought) also are negligible. Direct impacts from the Natural Gas PFR at NGS would be negligible.

3.7.4.3.1.4 Effects of Airborne Deposition of Trace Elements on Water Quality within a 20-km Radius of the Station

Estimated airborne deposition of trace elements (arsenic, mercury, and selenium) for the Natural Gas PFR is described in Chapter 2.0 and the Air Quality section. Proportional reductions in emissions from the Proposed Action are anticipated under this alternative. Because of this, proportional reductions of deposited concentrations also are anticipated from NGS under this alternative. Since only negligible effects would occur from NGS under the Proposed Action, impacts under the Natural Gas PFR also would be negligible. Negligible direct effects would occur in the Near-field study area, the southwest gap area (Colorado River below Lake Powell) and in the northeast gap area (Colorado River above Lake Powell). Negligible direct effects also would occur along the San Juan River study area.

3.7.4.3.2 Proposed Kayenta Mine Complex

Under the Natural Gas PFR, it is assumed that all proposed coal areas will be mined, but at a lower rate and on a modified schedule compared to the Proposed Action. For the 3-Unit Operation, coal production is estimated to range between 7.135 million tons per year (tpy) to 7.714 tpy, compared to 8.100 million tpy for the Proposed Action 3-Unit Operation. For the 2-Unit Operation, coal production is estimated to range between 4.535 million tpy to 5.114 million tpy, compared to 5.500 million tpy for the Proposed Action 2-Unit Operation. The extent of mine-related surface disturbance could be modified by proportional changes from the Proposed Action, as estimated in **Table 3.7-37**.

Table 3.7-37 Proposed KMC Surface Disturbance Estimates, Proposed Action Compared to the Natural Gas PFR Alternative

NGS Operation	Proposed Action Disturbance (acres)	Natural Gas PFR, 100-MW Disturbance (acres)	Natural Gas PFR, 250-MW Disturbance (acres)
NGS 3-Unit	5,230	4,968	4,602
NGS 2-Unit	4,741	4,409	3,888

3.7.4.3.2.1 Effects of Mine-related Pumping on N-Aquifer Groundwater Levels and Quality

Since mining activities and the overall extent of supporting components (e.g., access roads) would be the same as or similar to those for the Proposed Action, mine-related rates of groundwater withdrawals from the N-Aquifer are assumed not to change. Because of this, the Natural Gas PFR would generate minor mine-related effects on N-Aquifer water levels and negligible effects on groundwater quality. Direct effects would be the same as described for the Proposed Action.

3.7.4.3.2.2 Effects of Mine-related N-Aquifer Pumping on Springs, Seeps, and Stream Baseflows

Mine-related rates of groundwater withdrawals from the N-Aquifer are assumed not to change. Because of this, the Natural Gas PFR would generate none to negligible mine-related effects on springs, seeps and stream baseflows associated with N-Aquifer sources. Direct effects would be the same as described for the Proposed Action.

3.7.4.3.2.3 Effects of Mining Activities on Groundwater Levels and Water Quality in the Wepo Formation, Alluvial Aquifers, and Related Shallow Springs and Seeps

Similar to the Proposed Action, groundwater levels and water quality in these shallower aquifers would be affected by variations in natural background conditions such as precipitation rates, localized recharge, and geologic characteristics. Negligible impacts to water levels would result. Concentrations of water quality constituents such as sulfate and TDS would increase in areas affected by mining, but would remain within those standards or recommended values that have been used as benchmarks. These effects would be slightly less than described for a comparable Proposed Action operation, due to the decrease in new mining disturbance under a Natural Gas PFR. Localized minor water quality impacts would result. Existing surface water uses (habitat and livestock watering) are not generally supplied by access to shallow groundwater. Ongoing availability of supplies from PWCC ponds and impoundments would continue to support these uses in and near the leasehold.

3.7.4.3.2.4 Effects of Mining Activities on Surface Water Flows and Water Quality in Streams and Ponds

New mining disturbance would be somewhat less than in a comparable Proposed Action operation, as depicted in **Table 3.7-37** above. Because of this, the amount of surface water draining to and retained in temporary ponds may slightly decline from Proposed Action estimates. Whether or not less water would be retained would depend on specific mine configurations that are not currently known. Due to downstream lateral inflows and high background rates of evapotranspiration and channel seepage, effects downstream of the leasehold would be none to negligible. As with a Proposed Action operation, surface water quality would be maintained by continuing mine water management programs. These would include sediment retention, reclamation and best management practices to control erosion and runoff, and monitoring and mitigation. Existing water uses (habitat and livestock watering) would not be affected, due to ongoing availability of supplies from PWCC ponds and impoundments.

3.7.4.3.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

The potential impacts to water resources, and the approaches to operations and maintenance that would avoid such impacts, would be the same as those described for the Proposed Action. By conducting activities within appropriate guidelines and complying with permit approvals and conditions, no impacts to water resources would occur.

3.7.4.3.4 Project Impact Summary – All Project Components

Based on the assumptions for this alternative, there would be slightly less effects on Lake Powell water levels and extent than under a Proposed Action operation. The overall impacts to lake extent and water level would be negligible. Differences from a respective Proposed Action operation would be negligible. Somewhat less trace element deposition (for arsenic, mercury, and selenium) from NGS emissions would occur, relative to a comparable power generation rate from a Proposed Action operation. This would reduce the potential NGS impacts to surface water quality from a Natural Gas PFR to negligible levels.

Mine-related N-Aquifer impacts at the Proposed KMC would be the same as those from the Proposed Action. Impacts to groundwater levels and quality in shallow aquifers on the leasehold would be the same or slightly less than in a comparable Proposed Action, due to a reduction in new mining disturbance and the potential for corresponding changes in mine configurations. Similarly, potential surface water impacts would be the same or slightly less than a comparable Proposed Action operation. Existing water uses for livestock and habitat would be maintained the same as under the Proposed Action, due to continuing access to PWCC ponds and impoundments.

3.7.4.3.5 Cumulative Impacts

The cumulative actions and resource considerations for the Natural Gas PFR Alternative parallel those listed and described for the Proposed Action.

3.7.4.3.5.1 Navajo Generating Station

Effects of Cumulative Water Withdrawals on Water Level and Surface Area of Lake Powell

Potential cumulative impacts could result from combined withdrawals from Lake Powell, including those from NGS and the proposed Lake Powell Pipeline Project. Other included water projects (LTEMP and the San Juan Pipeline) would not create cumulative impacts from water withdrawals, as was described for the Proposed Action. Estimated potential cumulative changes in water levels and reservoir extents are indicated in **Table 3.7-38** below.

Table 3.7-38 Estimated Cumulative Effects of Natural Gas PFR Water Withdrawals and Lake Powell Pipeline Project on Lake Powell

Typical Water Use[1]	Reservoir Status	Typical 100-MW Annual Water Use (acre-feet per year)	Predicted 100-MW Water Level Reduction (inches)	Predicted 100-MW Lake Area Reduction (acres)	Typical 250-MW Annual Water Use (acre-feet per year)	Predicted 250-MW Water Level Reduction (inches)	Predicted 250-MW Lake Area Reduction (acres)
NGS 3-Unit Operation and Lake Powell Pipeline	Normal Pool	27,840 + 86,250	8.5	573.1	25,230 + 86,250	8.3	526.1
	Extreme Drought	27,840 + 86,250	18.6	681.7	25,230 + 86,250	18.2	666.2
NGS 2-Unit Operation and Lake Powell Pipeline	Normal Pool	17,986 + 86,250	7.8	491.9	16,052 + 86,250	7.6	591.4
	Extreme Drought	17,986 + 86,250	17.0	622.9	16,052 + 86,250	16.7	611.4

[1] Tabulated values reflect arithmetic rounding differences and interpolation from existing Lake Powell data.

Source: Reclamation 2009, 2007; Washington County Water Conservancy District 2016.

As can be seen from the table above, potential cumulative withdrawals would have a more substantial effect on the water level and surface area of Lake Powell than NGS withdrawals alone. These would be negligible to minor impacts. Differences between these estimated cumulative Natural Gas PFR changes and those of a comparable cumulative Proposed Action operation are negligible.

Effects of Cumulative Airborne Deposition of Trace Elements on Water Quality within the Overall Surface Water Study Area

The very small contributions of selected trace elements (arsenic, mercury, selenium) predicted for the Proposed Action would be reduced in NGS emissions from this alternative. Other cumulative contributions would not change, so impacts to surface water quality in the Colorado River, Lake Powell, and the San Juan River would be very similar to cumulative impacts described for a corresponding Proposed Action operation. Negligible water quality impacts would occur in Lake Powell and along the upstream and downstream sections of the Colorado River. Minor to moderate water quality impacts would occur along the San Juan River.

Past and Present Effects of Water Management at NGS on N-Aquifer Groundwater Quality

As described previously in the Affected Environment discussion, a zone of perched water occurs at shallow depths below the NGS plant area. This water results from small leaks at plant components such in the cooling tower area, from previously unlined ponds, and some drainage ditches. A perched water recovery, monitoring, and reporting program was previously established and implemented in coordination with the USEPA to address conditions at the plant. This would be a continuing activity under the Natural Gas PFR Alternative. No past or present impacts to N-Aquifer water quality have occurred.

3.7.4.3.5.2 Proposed Kayenta Mine Complex

Cumulative effects at the KMC could result from mine-related N-Aquifer pumping combined with projected community pumping. In addition, concerns have been expressed that retention of surface water at the proposed KMC could reduce water availability for other uses at distances far downstream of the coal leasehold. Such uses could involve agriculture along Moenkopi Wash, retention for livestock watering downstream on Dinnebito Wash, or others. Other cumulative impact considerations at the proposed KMC would parallel those described for the Proposed Action.

Cumulative Effects on N-Aquifer Water Levels and Groundwater Quality

Since combined N-Aquifer pumping rates under this alternative would be the same as those for the Proposed Action, potential cumulative impacts would be the same. Minor to moderate effects on N-Aquifer water levels would occur, and negligible impacts to N-Aquifer water quality would occur.

Effects of Combined Community and Mine-related Pumping on N-Aquifer Springs, Seeps, and Stream Baseflows

Since combined N-Aquifer pumping rates under this alternative would be the same as those for the Proposed Action, potential cumulative impacts would be the same as for the Proposed Action. Minor to moderate drawdown would occur in the N-Aquifer wells. Discharges at some N-Aquifer springs would be reduced by minor amounts, whereas none to negligible effects would occur at others. Cumulative declines in N-Aquifer contributions to stream baseflows would be negligible to major, depending on the stream location.

Effects of Mining Activities on Surface Water Flows for Cumulative Downstream Uses

These impacts would be the same as described for the Proposed Action. Since pumping for the Natural Gas PFR would have none to negligible effects on surface water flows from the leasehold and have none to negligible effect on channel flows at USGS gages further downstream on Moenkopi Wash or Dinnebito Wash, there would be no cumulative effects on distant cumulative downstream uses under this alternative.

3.7.4.3.5.3 Transmission Systems and Communication Sites

No cumulative impacts to water resources would occur, assuming that transmission line operations and maintenance would comply with regulatory permit requirements and applicable agency ROW stipulations related to water resource features.

3.7.4.4 Renewable Partial Federal Replacement Alternative

Under the Renewable PFR Alternative, a selected quantity of power between 100 MW and 250 MW would be contracted for under a long-term power purchase agreement from a currently unidentified, existing renewable energy power source, displacing an equivalent amount of power from the federal share of NGS generation. As the site is assumed to be an existing facility, prior disturbance impacts to water resources are not evaluated.

This discussion is divided into two parts. The first part describes assumptions about the alternative electrical supply site and operational characteristics and primary water resources impacts that have occurred or would occur. The second part addresses the impacts to water resources from reducing the power generated at NGS, with consequent reductions in coal production at the Kayenta Mine.

This alternative assumes that an existing source of power from renewable energy would be used to reduce (curtail) NGS 3-Unit Operation or 2-Unit Operation by 100 MW to 250 MW of electricity. Because the facility is unknown but assumed to currently exist, prior disturbance impacts to water resources are not evaluated. The following list presents key assumptions about water resources related to an existing renewable energy-fueled electrical power generating plant. Based on these characteristics, future water resources impacts at such a site would be none to negligible. The following water management-related aspects of such a facility are assumed:

- A renewable energy power plant would typically be located on a dry, upland site of approximately 100 acres. No additional surface disturbance would be required over time.
- Existing transmission lines from the facility, would have been constructed, operated, and maintained in accordance with applicable agency ROW permit stipulations and construction storm water permit requirements (including a Storm Water Pollution Prevention Plan), federal floodplain requirements (Executive Order 11988/13690), and hydraulic considerations for channel scour and bank migration at stream crossings.
- An SPCC Plan has been implemented and maintained to prevent, or respond to and report, spills or leaks of petroleum products. Operations and maintenance activities are conducted in compliance with a current industrial NPDES permit, with attendant Storm Water Pollution Prevention Plan.
- All water used for potable or sanitary uses and for other operational uses (e.g., dust suppression at the plant site and access roads, etc.) has been obtained through existing water rights. Any depletions have been approved and mitigated if necessary through applicable agency requirements and approvals.
- Only non-hazardous materials are disposed of in landfills on the site.
- The renewable energy source that generates power would not result in deposition to surface water of the trace elements associated with coal combustion under the Proposed Action. This difference in emissions is addressed in the Air Quality resource section.

Impact issues for this PFR alternative are discussed across the range of NGS unit operations (3-Unit and 2-Unit) and associated alternative power reductions (100 MW and 250 MW) from the least NGS power reduction to the greatest. Reductions in NGS power generation would proportionally reduce the quantity of coal delivered from the Kayenta Mine. The focus of this discussion is to distinguish differences in impacts within the operational range of the alternative to provide a basis for comparison with the Proposed Action.

3.7.4.4.1 Navajo Generating Station

The following topics discuss potential impacts water resources if 100 MW to 250 MW of power generation were replaced at NGS. Under this alternative, alternative power would be purchased from an existing, renewable source of electrical power generation.

3.7.4.4.1.1 Impacts to Surface Water or Groundwater Quantity or Quality from Dry Ash Disposal

Potential impact considerations would be similar to those described for the Natural Gas PFR and the Proposed Action, 2-Unit Operation. Because of these factors, no impacts to water resources at the dry ash disposal area would occur.

3.7.4.4.1.2 Impacts to Surface Water or Groundwater from Spills or Leaks at Fluid Storage or Evaporation Ponds

Potential impact considerations would be similar to those described for the Natural Gas PFR. No water resources impacts would occur. Similar to the Proposed Action and the Natural Gas PFR, water management under this alternative would include practices and procedures described in the Groundwater Protection Plan. These would include continued implementation of the Perched Water Dewatering Plan (**Appendix 1B**) and the Groundwater Monitoring Plan both included in **Appendix 1B**. Because of ongoing recovery and discharge of leaks to the plant process water stream, no impacts to the N-Aquifer would occur under this alternative. As with the Proposed Action and alternatives, groundwater protection and related monitoring would avoid or mitigate water resources impacts at NGS under this alternative.

3.7.4.4.1.3 Effects of Water Withdrawals for NGS on Water Levels and Surface Area of Lake Powell

Potential impact considerations would be similar to those described for the Natural Gas PFR. Negligible water resources impacts would occur.

3.7.4.4.1.4 Effects of Airborne Deposition of Trace Elements on Water Quality within a 20-km Radius of the Station

Potential impact considerations would be similar to those described for the Natural Gas PFR. Negligible water resources impacts would occur.

3.7.4.4.2 Proposed Kayenta Mine Complex

Under the Renewable PFR, it is assumed that all proposed coal areas will be mined, but at a lower rate and on a modified schedule compared to the Proposed Action. For the 3-Unit Operation, coal production is estimated to range between 7.537 million tpy to 7.875 million tpy, compared to 8.100 million tpy for the Proposed Action 3-Unit Operation. For the 2-Unit Operation, coal production is estimated to range between 4.937 million tpy to 5.275 million tpy, compared to 5.500 million tpy for the Proposed Action 2-Unit Operation. The extent of mine-related surface disturbance could be modified by proportional changes from the Proposed Action, as estimated in **Table 3.7-39**.

Table 3.7-39 Proposed KMC Surface Disturbance Estimates, Proposed Action Compared to the Renewable PFR Alternative

NGS Operation	Proposed Action Disturbance (acres)	Renewable PFR, 100-MW Disturbance (acres)	Renewable PFR, 250-MW Disturbance (acres)
NGS 3-Unit	5,230	5,072	4,863
NGS 2-Unit	4,741	4,551	4,267

3.7.4.4.2.1 Effects of Mine-related Pumping on N-Aquifer Groundwater Levels and Quality

Potential impact considerations would be similar to those described for the Natural Gas PFR. Because of this, the Renewable PFR would generate minor mine-related effects on N-Aquifer water levels and negligible effects on groundwater quality.

3.7.4.4.2.2 Effects of Mine-related N-Aquifer Pumping on Springs, Seeps, and Stream Baseflows

Mine-related rates of groundwater withdrawals from the N-Aquifer are assumed not to change. Because of this, the Renewable PFR would generate none to negligible mine-related effects on springs, seeps and stream baseflows associated with N-Aquifer sources.

3.7.4.4.2.3 Effects of Mining Activities on Groundwater Levels and Water Quality in the Wepo Formation, Alluvial Aquifers, and Related Shallow Springs and Seeps

Groundwater levels and water quality in these shallower aquifers would be affected by variations in natural background conditions. Negligible impacts to water levels would result. Water quality effects would be slightly less than described for a comparable Proposed Action operation, due to the decrease in new mining disturbance under a Renewable PFR. Localized minor water quality impacts would result. Ongoing availability of supplies from PWCC ponds and impoundments would continue to support these livestock and wildlife uses in and near the leasehold.

3.7.4.4.2.4 Effects of Mining Activities on Surface Water Flows and Water Quality in Streams and Ponds

New mining disturbance would be somewhat less than in a comparable Proposed Action operation, as depicted in **Table 3.7-39** above. Impact considerations would be the same as those described for the Natural Gas PFR. Due to downstream lateral inflows and high background rates of evapotranspiration and channel seepage, effects downstream of the leasehold would be none to negligible. Surface water quality would be maintained by continuing mine water management programs, with none to negligible impacts. Existing water uses (habitat and livestock watering) would not be affected, due to ongoing availability of supplies from PWCC ponds and impoundments.

3.7.4.4.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

3.7.4.4.4 Project Impact Summary – All Project Components

Based on the assumptions for this alternative, there would be slightly less effects on Lake Powell water levels and extent than under a Proposed Action operation. There would be none to negligible differences between the Renewable PFR and the Natural Gas PFR. The overall impacts to lake extent and water level would be negligible. Differences from a respective Proposed Action operation would be negligible. Somewhat less trace element deposition (for arsenic, mercury, and selenium) from NGS emissions would occur, relative to a comparable power generation rate from a Proposed Action operation. This would reduce the potential NGS impacts to surface water quality from a Renewable PFR to negligible levels. Transmission line impacts would be none, similar to the Natural Gas PFR.

Mine-related N-Aquifer impacts at the Proposed KMC would be the same as those from the Proposed Action. Impacts to groundwater levels and quality in shallow aquifers on the leasehold would be the same or slightly less than in a comparable Proposed Action, due to a reduction in new mining disturbance and the potential for corresponding changes in mine configurations. Similarly, potential surface water impacts would be the same or slightly less than a comparable Proposed Action operation. Existing water uses for livestock and habitat would be maintained the same as under the Proposed Action, due to continuing access to PWCC ponds and impoundments.

3.7.4.4.5 Cumulative Impacts

The cumulative actions and considerations for this alternative parallel those for the Proposed Action and Natural Gas PFR Alternative.

3.7.4.4.5.1 Navajo Generating Station

Effects of Cumulative Water Withdrawals on Water Level and Surface Area of Lake Powell

Potential cumulative withdrawal effects would be very similar to those tabulated for the Proposed Action and Natural Gas PFR. Cumulative withdrawals would have a more substantial effect on the water level and surface area of Lake Powell than NGS withdrawals alone. These would be negligible to minor impacts. Differences between the estimated cumulative Renewable PFR changes and those of a comparable cumulative Proposed Action operation would be negligible.

Effects of Cumulative Airborne Deposition of Trace Elements on Water Quality within the Overall Surface Water Study Area

The very small contributions of selected trace elements (arsenic, mercury, selenium) predicted for the Proposed Action would be reduced in NGS emissions from this alternative. Other cumulative contributions would not change, so impacts to surface water quality in the Colorado River, Lake Powell, and the San Juan River would be very similar to cumulative impacts described for a corresponding Proposed Action operation. Negligible water quality impacts would occur in Lake Powell and along the upstream and downstream sections of the Colorado River. Minor to moderate water quality impacts would occur along the San Juan River.

Past and Present Effects of Water Management at NGS on N-Aquifer Groundwater Quality

As described previously in the Affected Environment discussion, a zone of perched water occurs at shallow depths below the NGS plant area. This water results from small leaks at plant components such in the cooling tower area, from previously unlined ponds, and some drainage ditches. A perched water recovery, monitoring, and reporting program was previously established and implemented in coordination with the USEPA to address conditions at the plant. This would be a continuing activity under the Natural Gas PFR Alternative. No past or present impacts to N-Aquifer water quality have occurred.

3.7.4.4.5.2 Proposed Kayenta Mine Complex

Cumulative effects at the KMC could result from mine-related N-Aquifer pumping combined with projected community pumping. In addition, concerns have been expressed that retention of surface water at the proposed KMC could reduce water availability for other uses at distances far downstream of the coal leasehold. Such uses could involve agriculture along Moenkopi Wash, retention for livestock watering downstream on Dinnebito Wash, or others.

Cumulative Effects on N-Aquifer Water Levels and Groundwater Quality

Because combined N-Aquifer pumping rates under this Renewable PFR Alternative would be the same as those for the Proposed Action, potential cumulative impacts would be the same. Minor to moderate effects on N-Aquifer water levels would occur, and negligible impacts to N-Aquifer water quality would occur.

Effects of Combined Community- and Mine-related Pumping on N-Aquifer Springs, Seeps, and Stream Baseflows

Because combined N-Aquifer pumping rates under this alternative would be the same as those for the Proposed Action, potential cumulative impacts would be the same as for the Proposed Action and the Natural Gas PFR. Minor to moderate drawdown would occur in the N-Aquifer wells. Discharges at some N-Aquifer springs would be reduced by minor amounts, whereas none to negligible effects would occur at others. Cumulative declines in N-Aquifer contributions to stream baseflows would be negligible to major, depending on the stream location.

Effects of Mining Activities on Surface Water Flows for Cumulative Downstream Uses

Because surface water flows from the leasehold have no or negligible effect on channel flows at USGS gages further downstream on Moenkopi Wash or Dinnebito Wash, there would be no effects on distant cumulative downstream uses under this Renewable Alternative.

3.7.4.4.5.3 Transmission Systems and Communication Sites

No cumulative impacts to water resources would occur, assuming that transmission line operations and maintenance would comply with regulatory permit requirements and applicable agency ROW stipulations related to water resource features.

3.7.4.5 Tribal Partial Federal Replacement Alternative

Under the Tribal PFR Alternative, between 100 MW and 250 MW of power generation from the NGS would be replaced by power supplied by a new photovoltaic generation facility on tribal land, displacing an equivalent amount of power from the federal share of NGS generation. The construction of a new photovoltaic generation site on tribal land would result in between 1,200 and 3,000 acres of new surface disturbance. The Tribal PFR facility would be analyzed in a separate NEPA process once a facility location is identified.

This discussion is divided into two parts. The first part describes assumptions about the alternative photovoltaic supply site and operational characteristics. Water resources impacts that could occur would be addressed in subsequent NEPA actions. The second part addresses the impacts to water resources from reducing the power generated at NGS with consequent reductions in coal production at the Kayenta Mine.

The following list presents key assumptions about water resources related to a new photovoltaic generation site on tribal land. Based on these characteristics, future water resources impacts at such a site would be none to negligible. The following water management-related aspects of such a facility are assumed as noted below.

- A photovoltaic power site would typically be located on a dry, upland site. New surface disturbance would be required over time, and would be conducted in compliance with applicable regulatory requirements and agency stipulations.
- Transmission lines from the facility would be constructed in accordance with applicable agency ROW permit stipulations and construction storm water permit requirements (including a Storm Water Pollution Prevention Plan), federal floodplain requirements (Executive Order 11988/13690), and hydraulic considerations for channel scour and bank migration at stream crossings.
- An SPCC Plan would be implemented and maintained to prevent, or respond to and report, spills or leaks of petroleum products. Operations and maintenance activities would be conducted in compliance with a current industrial NPDES permit, with attendant Storm Water Pollution Prevention Plan.
- All water used for potable or sanitary uses and for other operational uses (e.g., solar panel washing and maintenance, dust suppression at the plant site and access roads, etc.) would be obtained through existing water rights. Any depletions would be approved and mitigated if necessary through applicable agency requirements and approvals.
- Only non-hazardous materials would be disposed of in landfills on the site.

- The tribal photovoltaic energy source that generates power would not result in deposition to surface water of the trace elements associated with coal combustion under the Proposed Action. This difference in emissions is addressed in Section 3.1.

Impact issues for this PFR alternative are discussed across the range of NGS unit operations (3-Unit and 2-Unit) and associated alternative power reductions (100 MW and 250 MW) from the least NGS power reduction to the greatest. Reductions in NGS power generation would proportionally reduce the quantity of coal delivered from the Kayenta Mine. The focus of this discussion is to distinguish differences in impacts within the operational range of the alternative to provide a basis for comparison with the Proposed Action.

3.7.4.5.1 Navajo Generating Station

The following topics discuss potential impacts to water resources if 100 MW to 250 MWs of power generation were replaced at NGS. Under this alternative, alternative power would be purchased from a new photovoltaic source of electrical power generation on tribal land.

3.7.4.5.1.1 Impacts to Surface Water or Groundwater Quantity or Quality from Dry Ash Disposal

Potential impact considerations would be similar to those described for the Natural Gas PFR. Because of these factors, no impacts to water resources at the dry ash disposal area would occur.

3.7.4.5.1.2 Impacts to Surface Water or Groundwater from Spills or Leaks at Fluid Storage or Evaporation Ponds

Potential impact considerations would be similar to those described for the Natural Gas PFR. No water resources impacts would occur. Similar to the Proposed Action and the Natural Gas PFR, water management under this alternative would include practices and procedures described in the Groundwater Protection Plan. These would include continued implementation of the Perched Water Dewatering Plan (**Appendix 1B**). Because of ongoing recovery and discharge of leaks to the plant process water stream, no impacts to the N-Aquifer would occur under this alternative.

3.7.4.5.1.3 Effects of Water Withdrawals for NGS on Water Levels and Surface Area of Lake Powell

Potential impact considerations would be similar to those described for the Natural Gas PFR. Negligible water resources impacts would occur.

3.7.4.5.1.4 Effects of Airborne Deposition of Trace Elements on Water Quality within a 20-km Radius of the Station

Potential impact considerations would be similar to those described for the Natural Gas PFR. Negligible water resources impacts would occur.

3.7.4.5.2 Proposed Kayenta Mine Complex

Under the Tribal PFR, it is assumed that all proposed coal areas will be mined, but at a lower rate and on a modified schedule compared to the Proposed Action. For the 3-Unit Operation, coal production is estimated to range between 7.701 million tpy to 7.941 million tpy, compared to 8.100 million tpy for the Proposed Action 3-Unit Operation. For the 2-Unit Operation, coal production is estimated to range between 5.101 million tpy to 5.341 million tpy, compared to 5.500 million tpy for the Proposed Action 2-Unit Operation. The extent of mine-related surface disturbance could be modified by proportional changes from the Proposed Action, as estimated in **Table 3.7-40**.

Table 3.7-40 Proposed KMC Surface Disturbance Estimates, Proposed Action Compared to the Tribal PFR Alternative

NGS Operation	Proposed Action Disturbance (acres)	Tribal PFR, 100-MW Disturbance (acres)	Tribal PFR, 250-MW Disturbance (acres)
NGS 3-Unit	5,230	5,124	4,968
NGS 2-Unit	4,741	4,599	4,409

3.7.4.5.2.1 Effects of Mine-related Pumping on N-Aquifer Groundwater Levels and Quality

Potential impact considerations would be similar to those described for the Natural Gas PFR. Because of this, the Tribal PFR would generate minor mine-related effects on N-Aquifer water levels and negligible effects on groundwater quality.

3.7.4.5.2.2 Effects of Mine-related N-Aquifer Pumping on Springs, Seeps, and Stream Baseflows

Mine-related rates of groundwater withdrawals from the N-Aquifer are assumed not to change. Because of this, the Tribal PFR would generate none to negligible mine-related effects on springs, seeps and stream baseflows associated with N-Aquifer sources.

3.7.4.5.2.3 Effects of Mining Activities on Groundwater Levels and Water Quality in the Wepo Formation, Alluvial Aquifers, and Related Shallow Springs and Seeps

Groundwater levels and water quality in these shallower aquifers would be affected by variations in natural background conditions. Negligible impacts to water levels would result. Water quality effects would be slightly less than described for a comparable Proposed Action operation, due to the decrease in new mining disturbance under a Tribal PFR. Localized minor water quality impacts would result. Ongoing availability of supplies from PWCC ponds and impoundments would continue to support these livestock and wildlife uses in and near the leasehold.

3.7.4.5.2.4 Effects of Mining Activities on Surface Water Flows and Water Quality in Streams and Ponds

New mining disturbance would be somewhat less than in a comparable Proposed Action operation, as depicted in **Table 3.7-40** above. Impact considerations would be the same as those described for the Natural Gas PFR. Due to downstream lateral inflows and high background rates of evapotranspiration and channel seepage, effects downstream of the leasehold would be none to negligible. Surface water quality would be maintained by continuing mine water management programs, with none to negligible impacts. Existing water uses (habitat and livestock watering) would not be affected, due to ongoing availability of supplies from PWCC ponds and impoundments.

3.7.4.5.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

Additional disturbance could occur to an unknown number of acres related to connecting a new photovoltaic generation site on tribal land to the existing transmission system and would be evaluated in a subsequent NEPA action. Assuming that appropriate tribal and federal ROW permit approvals and agreements would be obtained or maintained, and that those would entail provisions and stipulations protective of water resources (see discussions under “Regulatory Framework” and the Proposed Action), then no transmission system impacts to water resources would occur under this alternative.

3.7.4.5.4 Project Impact Summary – All Project Components

Based on the assumptions for this alternative, there would be slightly less effects on Lake Powell water levels and extent that under a Proposed Action operation. There would be none to negligible differences between the Tribal PFR and the Natural Gas PFR. The overall impacts to lake extent and water level would be negligible. Differences from a respective Proposed Action operation would be negligible. Somewhat less trace element deposition (for arsenic, mercury, and selenium) from NGS emissions would occur, relative to a comparable power generation rate from a Proposed Action operation. This would reduce the potential NGS impacts to surface water quality from a Tribal PFR to negligible levels.

Mine-related N-Aquifer impacts at the Proposed KMC would be the same as those from the Proposed Action. Impacts to groundwater levels and quality in shallow aquifers on the leasehold would be the same or slightly less than in a comparable Proposed Action, due to a reduction in new mining disturbance and the potential for corresponding changes in mine configurations. Similarly, potential surface water impacts would be the same or slightly less than a comparable Proposed Action operation. Existing water uses for livestock and habitat would be maintained the same as under the Proposed Action, due to continuing access to PWCC ponds and impoundments.

3.7.4.5.5 Cumulative Impacts

3.7.4.5.5.1 Navajo Generating Station

<u>Effects of Cumulative Water Withdrawals on Water Level and Surface Area of Lake Powell</u>

Potential cumulative withdrawal effects would be very similar to those tabulated for the Natural Gas PFR. Cumulative withdrawals would have a more substantial effect on the water level and surface area of Lake Powell than NGS withdrawals alone. These would be negligible to minor impacts. Differences between the estimated cumulative Tribal PFR changes and those of a comparable cumulative Proposed Action operation are negligible.

<u>Effects of Cumulative Airborne Deposition of Trace Elements on Water Quality within the Overall Surface Water Study Area</u>

The very small contributions of selected trace elements (arsenic, mercury, selenium) predicted for the Proposed Action would be reduced in NGS emissions from this alternative. Other cumulative contributions would not change, so impacts to surface water quality in the Colorado River, Lake Powell, and the San Juan River would be very similar to cumulative impacts described for a corresponding Proposed Action operation. Negligible water quality impacts would occur in Lake Powell and along the upstream and downstream sections of the Colorado River. Minor to moderate water quality impacts would occur along the San Juan River.

<u>Past and Present Effects of Water Management at NGS on N-Aquifer Groundwater Quality</u>

As described previously in the Affected Environment discussion, a zone of perched water occurs at shallow depths below the NGS plant area. This water results from small leaks at plant components such in the cooling tower area, from previously unlined ponds, and some drainage ditches. A perched water recovery, monitoring, and reporting program was previously established and implemented in coordination with the USEPA to address conditions at the plant. This would be a continuing activity under the Tribal PFR Alternative. No past or present impacts to N-Aquifer water quality have occurred.

3.7.4.5.5.2 Proposed Kayenta Mine Complex

Cumulative effects at the KMC could result from mine-related N-Aquifer pumping combined with projected community pumping. In addition, concerns have been expressed that retention of surface water at the proposed KMC could reduce water availability for other uses at distances far downstream of the coal leasehold. Such uses could involve agriculture along Moenkopi Wash, retention for livestock watering downstream on Dinnebito Wash, or others.

Cumulative Effects on N-Aquifer Water Levels and Groundwater Quality

Because combined N-Aquifer pumping rates under this Tribal PFR Alternative would be the same as those for the Proposed Action, potential cumulative impacts would be the same. Minor to moderate effects on N-Aquifer water levels would occur, and negligible impacts to N-Aquifer water quality would occur.

Effects of Combined Community and Mine-related Pumping on N-Aquifer Springs, Seeps, and Stream Baseflows

Because combined N-Aquifer pumping rates under this Tribal Alternative would be the same as those for the Proposed Action, potential cumulative impacts would be the same as for the Proposed Action and the Natural Gas PFR. Minor to moderate drawdown would occur in the N-Aquifer wells. Discharges at some N-Aquifer springs would be reduced by minor amounts, whereas none to negligible effects would occur at others. Cumulative declines in N-Aquifer contributions to stream baseflows would be negligible to major, depending on the stream location.

Effects of Mining Activities on Surface Water Flows for Cumulative Downstream Uses

Because surface water flows from the leasehold have none to negligible effect on channel flows at USGS gages further downstream on Moenkopi Wash or Dinnebito Wash, there would be no effects on distant cumulative downstream uses under this Tribal Alternative.

3.7.4.5.5.3 Transmission Systems and Communication Sites

No cumulative impacts to water resources would occur, assuming that transmission line operations and maintenance would comply with regulatory permit requirements and applicable agency ROW stipulations related to water resource features.

3.7.4.6 No Action

Water resources topics addressed for the No Action Alternative remain in the general categories as those listed for the Proposed Action, but obviously the potential impacts would differ. Surface water quantity and quality, groundwater quantity and quality, and effects on existing water uses are the major topics of interest for the No Action Alternative, at both NGS and KMC.

3.7.4.6.1 Navajo Generating Station

3.7.4.6.1.1 Ash Disposal Area, Existing Ponds, and Other Components

As described in Chapter 1.0 for the No Action Alternative, some decommissioning activities would be initiated at the NGS in 2018, with effective shutdown of the plant occurring by the end of 2019. Ponds, landfills, industrial fluids and wastes, and other water-related components or materials would be addressed by SRP and other NGS participants through further site-specific closure planning and implementation. Decommissioning of other plant components and the transmission systems is described in the respectively titled section of **Appendix 1B**. A Professional Engineer would develop an industry-recognized and generally accepted good engineering practices closure plan (Groundwater Protection Plan). **Appendix 1B** provides further detail. USEPA regulations at time of closure and lease requirements would be used as the basis for plant decommissioning and environmental demolition requirements. The Groundwater Protection Plan would be the guidance document for water-related decommissioning work, with additional specific component plans, implementation, and monitoring conducted by SRP with appropriate agency coordination. This plan would include, but not be limited to:

- Investigating soil or material constituents in or adjacent to ponds and landfills, and compare them to appropriate screening levels;
- Recovering remaining perched water underlying the plant site and ash disposal area;
- Removing, decontaminating, or burying soils and other materials in place according to applicable federal requirements;
- Stabilizing remaining wastes and waste residues as necessary to support final cover, and installing final cover per the design requirements;
- Eliminating (e.g., through evaporation or other means) or solidifying free liquids and other residues, then stabilizing and covering the sites according to the design requirements;
- Controlling erosion and runoff;
- Monitoring and maintaining post-closure conditions related to cover integrity, runoff and erosion controls, and groundwater conditions. The types and durations of monitoring and maintenance activities would be pursuant to USEPA regulations at time of closure, including the CCR regulations, other applicable federal regulations, and lease requirements.
- Conducting closure and post-closure monitoring in accordance with the Groundwater Protection Plan and agency interactions.

Management of fluids and wastes would continue as the decommissioning process proceeds to minimize impacts to surface water resources during closure activities. Ongoing storm water management practices would continue to control erosion, runoff, and off-site movement of fluids or wastes. By continuing storm water management practices and implementing a coordinated closure design, long-term impacts to surface water resources at NGS would be avoided or reduced. Short-term impacts to surface water or groundwater quality could occur during decommissioning activities, due to inadvertent spills, leaks, storm damage, or runoff bypasses. If they occur, such events would be promptly mitigated through countermeasures.

Impacts to groundwater (N-Aquifer) resources would be avoided or reduced to unobservable levels during and after plant decommissioning. This would occur by continuing to implement the Groundwater Protection Plan and its accompanying Perched Water Dewatering Work Plan (**Appendix 1B**). Groundwater monitoring (and any recovery or remediation activities, if necessary) would continue according to commitments and agency coordination. With these procedures and practices, long-term, post-closure water resources impacts from the No Action Alternative would be avoided or mitigated.

Because of these practices, the No Action Alternative would create no future impacts to water resources from components within the NGS plant site.

3.7.4.6.1.2 Lake Powell

Under the No Action Alternative, NGS water supply withdrawals from Lake Powell would cease. The allocated consumptive water volume is 34,100 acre-feet per year. This volume would remain under the administration of the State of Arizona through its Colorado River water rights. The actual present and planned withdrawal volume at NGS is about 29,000 acre-feet per year. That amount could help meet other water demands. It represents about 0.11 percent of total reservoir water capacity at a pool elevation 3,700 feet, based on recent information (Reclamation 2007). If the water remained in storage at approximately that elevation, the existing reservoir surface area would increase by about 132 acres, to a total of about 160,782 acres. It is unknown what uses might be made of the water currently allocated to NGS. Water could be delivered elsewhere in Arizona to beneficial uses supported by Lake Powell and in the Upper Colorado River Basin.

Airborne deposition of arsenic, mercury, and selenium from NGS would cease within the 20-km radius near-field study area, and NGS would not contribute to cumulative regional rates of deposition in the outlying surface water study areas.

3.7.4.6.2 Proposed Kayenta Mine Complex

As described for No Action in Chapter 2.0, PWCC has indicated it would cease mining operations at the Kayenta Mine in 2019, and proceed to final reclamation of the Kayenta Mine, the former Black Mesa Mine, and all support facilities not otherwise approved as permanent facilities. Mine closure and reclamation would take place according to applicable permit documentation and provisions.

3.7.4.6.2.1 N-Aquifer Water Levels, Groundwater Quality, and Uses

Under the No Action, N-Aquifer pumping would decline in 2019 from its current withdrawal rate of about 1,200 to 1,400 acre-feet per year. Pumping would continue for reclamation operations, local water supplies, the Many Mules Navajo Nation water supply project, and dust suppression. These would require less water under the No Action than mining operations would during an action alternative. During the period 2020 through 2022, N-Aquifer pumping would decline to about 500 acre-feet per year. Subsequent rates would be approximately 100 acre-feet per year during reclamation. Reclamation activities would be completed in approximately 2033. This would be a similar reduction in N-Aquifer pumping as would occur in a Proposed Action option, but it would occur about 25 years sooner. About 100 acre-feet per year would be pumped from the PWCC wells mainly for domestic supplies after 2033.

Gradual increases to meet local domestic use demands for N-Aquifer water would continue under No Action after the Year 2033. Projected community water supply pumping from the N-Aquifer would continue into the future.

Under the No Action Alternative mining at the KMC ceases at the end of 2019. PWCC pumping would be reduced from 1,200 acre-feet per year at the end of 2019 to 500 acre-feet per year from 2020 through 2023 (3 years) then to 100 acre-feet per year from 2024 through 2033 (10 years). As noted previously, while mine pumping would be reduced and eventually cease completely, the cone of depression would continue to spread for many years. During the No Action Alternative, N-Aquifer water levels in the PWCC leasehold would start to recover within a year, and in nearby wells within a few years. However, as a result of recent mine-related pumping, water levels in some distant N-Aquifer wells will continue to fall for a period of time.

To assess the impact of the No Action Alternative on N-Aquifer water levels, data for the year 2057 were extracted from the groundwater flow model output. This year was selected as it is the year in which all mine pumping ceases in the proposed alternative and is within the reasonably foreseeable future in terms of population and water use projections. The groundwater flow model uses population and water use projections developed by the EIS team with input from the tribes and cooperating agencies. The model was run with community, windmill and PWCC pumping, and also with only community and windmill pumping; the difference of these two runs provides the water level change (drawdown) due to PWCC pumping (**Appendix WR-9**). It should be noted that both runs include the effects of past PWCC pumping on water levels prior to 2019.

Water level change (drawdown) from 2019 through 2057 due to community (including windmill) pumping and PWCC pumping was extracted from the model, and the relative percent of each on water level change in 2057 computed, as presented in **Table 3.7-41**. **Table 3.7-41** shows that the effects of mine pumping would continue (i.e., drawdown in most wells is still occurring in 2057, 25 year after PWCC pumping ceases) under the No Action Alternative, even though all mine-related pumping would have ceased. The table also shows that by 2057 water level change in most locations would be dominated by increasing community pumping.

Table 3.7-41 N-Aquifer Water Level Change from 2019 to 2057, Community and PWCC Effects, No Action Alternative

Community	Community (feet)	PWCC (feet)	Community / PWCC (percent)
Navajo			
Kayenta	147.04	3.18	98 / 2
Shonto	30.13	0.01	100 / 0
Dennehotso	32.48	0	100 / 0
Chilchinbito	102.47	13.75	88 / 12
Rough Rock	50.44	2.47	95 / 5
Forest Lake[1]	-16.38	-22.72	42 / 58
Pinon	62.71	14.73	81 / 19
Hard Rock	70.15	14	83 / 17
Shonto Junction	1.17	0.01	99 / 1
Red Lake	12.58	0.01	100 / 0
Rocky Ridge	52.23	11.09	82 / 18
Tuba City	58.17	0	100 / 0
Hopi			
Moenkopi	161.98	0.01	100 / 0
Hotevilla	39.93	2.69	94 / 6
Bacavi	31.62	2.51	93 / 7
Low Mountain	167.57	12.08	93 / 7
Kykostmovi	25.45	2.44	91 / 9
Hopi Civic Center	16.12	2.77	85 / 15
Shungopavi	10.24	1.99	84 / 16
HAMP[2]	172.17	10.99	94 / 6

[1] The water level at Forest Lake is still recovering from 2005 cessation of past higher PWCC pumping for Black Mesa coal slurry pipeline. This rise masks any drawdown that is continuing after PWCC pumping has ceased.

[2] Wells are placed at Hopi High School, Hopi Cultural Center, Shipaulovi, Second Mesa Day School, Keams Canyon and Polacca.

HAMP = Hopi Arsenic Mitigation Project.

Table 3.7-42 gives the projected depth to water in 2057 and shows that the effect of mine pumping on N-Aquifer depths to water would continue under the No Action Alternative, even though all mine pumping would have ceased. The table also shows that by 2057 the residual effect of PWCC pumping on the lift required to get water to the surface in key community production wells would be less than 2 percent of the total lift.

Table 3.7-42 No Action Alternative, 2019-2057 Percent Increase in N-Aquifer Lift at Key Community Production Wells due to PWCC Pumping

Community	Depth to Water (feet bgs)	PWCC Drawdown (feet)	Community / PWCC (percent)
Navajo			
Kayenta	568	3.18	99 / 1
Shonto	393	0.01	100 / 0
Dennehotso	47	0.0	100 / 0
Chilchinbito	638	13.75	98 / 2
Rough Rock	718	2.47	98 / 2
Forest Lake[1]	1,121	-22.72	98 / 2
Pinon	900	14.73	98 / 2
Hard Rock	789	14.0	98 / 2
Shonto Junction	7	0.01	100/ 0
Red Lake	200	0.01	100 / 0
Rocky Ridge	602	11.09	98 / 2
Tuba City	190	0.0	98 / 2
Hopi			
Moenkopi	562	0.0	100 / 0
Hotevilla	1,011	0.3	100 / 0
Bacavi	1,025	0.3	100 / 0
Low Mountain	834	1.8	99 / 1
Kykostmovi	281	1.0	99 / 1
Hopi Civic Center	440	0.7	99 / 1
Shungopovi	963	0.2	100 / 0
HAMP[2]	601	2.6	98 / 2

[1] Water level at Forest Lake is still recovering from 2005 cessation of past higher PWCC pumping for Black Mesa coal slurry pipeline.

[2] Wells are placed at Hopi High School, Hopi Cultural Center, Shipaulovi, Second Mesa Day School, Keams Canyon and Polacca.

HAMP = Hopi Arsenic Mitigation Project.

Impacts to springs would be the less than those identified as direct effects for the Proposed Action (**Table 3.7-20**) and more similar to those described for cumulative impacts considered under the Proposed Action. Predicted effects of the No Action Alternative on stream baseflows are indicated in **Table 3.7-31** as presented for the cumulative impact assessment under the Proposed Action. Predictions for the No Action in the Year 2110 indicate that community pumping then would decrease baseflows by zero to 0.145 cfs in the channels listed. The major baseflow declines due to No Action pumping effects from 2019 to 2110 would be at Chinle Creek (46.8 percent), Laguna Creek (42.2 percent), Polacca Wash (31.4 percent), and Begashibito Wash (18.3 percent). Locations where these effects were simulated are indicated on **Figures 3.7-3** and **3.7-12**.

3.7.4.6.2.2 Wepo Aquifer and Alluvial Groundwater Levels, Quality, and Uses

Both the alluvial aquifer and the Wepo aquifer are strongly influenced by climate and local recharge conditions. This would continue under the No Action Alternative. Alluvial groundwater levels and water quality would vary, and remain similar to the conditions described in the Affected Environment and **Appendix WR-3**. No other effects on alluvial groundwater levels or quality would result from the No Action. Similarly, Wepo Formation groundwater levels and water quality would remain similar to those described in the Affected Environment and **Appendix WR-5**. With reduced mining disturbance from the No Action Alternative, local drawdown in the Wepo Formation near mine pits would be reduced or avoided. In comparison to a Proposed Action option, this would reduce the potential for negligible to minor related impacts to springs and stream baseflows near the N-9, N-10, N-11 Extension, J-19, and J-21/J-21W coal resource areas. Similar to the Proposed Action and others alternatives. Anticipated impacts to the limited existing Wepo or alluvial water uses in or near the leasehold would be negligible under the No Action Alternative. Under the No Action, there would be less potential to disturb the various water features (springs, stream baseflows) in and near the areas that would be mined under a Proposed Action option. Comparing the direct effects of the No Action to the Proposed Action, the net difference between water availability and quality for existing uses is negligible.

3.7.4.6.2.3 Shallow Aquifer Springflows and Water Quality

Flows and water quality at shallow-aquifer springs would remain similar to those reported in **Appendix WR-4**. Conditions at springs with shallow-aquifer sources (the alluvium or Wepo Formation) would continue to reflect overall climatic trends and influences from local recharge and geologic conditions.

In the J-19 area, the removal of NSPG191 would not occur under the No Action. Comparing the Proposed Action to a No Action that would maintain NSPG191, there would be a small net difference between water availability and quality for existing uses in the J-19/J-21/J-21W area. NSPG191 has a monitored range of flows from 0.0 to 4.0 gpm, but typically it does not flow. When flowing, its average measured rate is 0.55 gpm. Permanent ponds or impoundments J21-C (2007); J21-RB (1980); J21-I (2012); J7-JR (2001); and J16-L (2007) already have been constructed and maintained by PWCC as alternative water supplies in the J-19/J-21/J-21W area. In light of these permanent features, maintaining spring NSPG191 would provide negligible benefits to existing livestock and wildlife water uses under the No Action Alternative.

3.7.4.6.2.4 Surface Water Flows, Water Quality, and Uses

As with previous phases of mine operations and reclamation, surface runoff at the proposed KMC would be managed through ponds, impoundments, ditches, and diversions. The effects of these structures on runoff water quantity were previously characterized as of Year 2019 for the Proposed Action (**Table 3.7-17**). From those projections, approximately 25 to 30 percent of runoff from the leasehold would be retained by water management practices. After reclamation, there would be approximately a seven percent reduction in the amount of runoff retained, generally paralleling the total indicated in **Table 3.7-25**.

Under the No Action Alternative, new mining at coal resource areas N-10 and N-11 Extension would not occur. Expanded mining at the N-9, J-19, J-21, and J-21W areas would not occur after Year 2018, since decommissioning at the NGS would be beginning. As a result, runoff quantities from these expansion areas and their upgradient watersheds would not be retained within the leasehold. Under the No Action Alternative, a projected 20 to 25 percent increase in retained runoff from post-2019 mining under the Proposed Action would not occur. Due to permanent post-mining impoundments, which provide livestock and habitat uses within the leasehold, approximately 20 percent of runoff would be retained after reclamation. This would be the same as that projected for the Proposed Action options, and would be a minor impact, entailing a hydrologic shift from shorter-term ephemeral or limited intermittent streamflows, to longer duration impounded water. Under the No Action Alternative, reclamation of these remaining temporary ponds would be accelerated. Permanent impoundments would remain to provide water used by livestock and wildlife.

Runoff water quality under the No Action Alternative be similar to that reflected in the tables presented in **Appendix WR-1**. In general, most water quality constituents would remain at concentrations within designated use standards. Sulfate and TDS concentrations would vary but generally would remain elevated, as they often are in background water quality. Total aluminum and lead concentrations would occasionally be elevated. These chemical conditions would parallel the water quality from undisturbed inflows and springs as documented outside the effects of mining. Since there would be less surface disturbance and a somewhat shorter reclamation time-frame at the proposed KMC, sediment yields from disturbed areas would be reduced more quickly under the No Action Alternative. This would create negligible effects, since sediment yields are well-controlled currently at the proposed KMC, and also would be under any action alternative.

3.7.4.6.3 Transmission Systems and Communication Sites

The NGS transmission system is an established part of the western U.S. transmission grid and supports reliability and delivery of power throughout the region, well beyond the power generated by the NGS. Therefore, under the No Action Alternative it is likely that that one, several, or all of the land owners/managers of the transmission line rights-of-way and communication site leases would renew some portion of the facilities to keep the power grid performing as expected.

In the event it is determined that some or all of the transmission systems and communication site ROWs are not renewed, a lengthy study and permitting process would need to occur before any decommissioning is initiated due to the essential and integral nature of these facilities with the western electric grid. As noted in Section 2.3.3, up to 4,826 acres within and alongside the transmission system corridors could be temporarily disturbed if the entirety of the transmission systems and communication sites were decommissioned and removed.

By conducting activities within appropriate guidelines and complying with permit approvals and conditions, impacts to water resources would be none to negligible. If decommissioning of the existing NGS transmission systems is required, it would follow the decommissioning approach as set forth in **Appendix 1B**. Resulting water resources impacts would be none to negligible.

3.7.4.6.4 No Action Impact Summary – All Project Components

For the NGS, the impact assessment for the No Action focuses on the potential for:

- Impacts to the N-Aquifer from plant and facilities decommissioning and reclamation;
- Effects of other water supply withdrawals on Lake Powell; and
- Surface water quality impacts from airborne deposition of selected trace elements in Lake Powell and the Colorado River from other regional power plants.

Potential water resources impacts at the NGS would be avoided or mitigated by site-specific closure planning and engineered practices that would close and reclaim ponds, landfills, industrial fluids and wastes, and other water-related components or materials. Closure planning and activities would be coordinated appropriately with the USEPA and Navajo Nation. Storm water management and the Groundwater Protection Plan (with its accompanying Perched Water Dewatering Work Plan) would continue to be implemented during plant closure and reclamation. The No Action Alternative would create no impacts to water resources from components within the NGS site.

NGS water supply withdrawals from Lake Powell would cease. This represents a negligible amount: about 0.11 percent of total reservoir water capacity. That water would remain under the administration of the State of Arizona. Scheduled releases and other withdrawals, such as the proposed Lake Powell Pipeline (if approved and completed), would continue to affect reservoir volume and extent.

NGS would not contribute to regional rates of airborne deposition of arsenic, mercury, or selenium in the outlying surface water study areas. This would be a negligible effect. Other coal-fired power plants in the region would continue to contribute these trace elements to surface waters in the study area. Generally these would be negligible effects, but water quality concerns would remain for the lower San Juan and Colorado rivers due to salinity and other constituents.

At the proposed KMC, the impact assessment for the No Action focuses on the potential for:

- Community pumping impacts to N-Aquifer groundwater levels and water quality;
- Reduced discharges in N-Aquifer springs and supported stream baseflows;
- Reduced groundwater levels and water quality in the shallower Wepo and alluvial aquifer zones in the leasehold after reclamation;
- Reduced flow rates, occurrence, or water quality at shallow springs and seeps, and corresponding effects on existing water uses in and near the coal leasehold after reclamation;
- Reduced flows or water quality in stream channels and corresponding effects on existing water uses in and near the coal leasehold after reclamation; and
- Additional retention of surface runoff in ponds and impoundments, and the suitability of retained water quality to support water uses in the mine-area locale after reclamation.

In the No Action case, existing mine-related N-Aquifer pumping would decline to about 500 acre-feet per year during the period 2020 through 2022. After that, pumping would continue for reclamation operations, local water supplies, the Many Mules project, and dust suppression. Rates would be approximately 100 acre-feet per year during reclamation until approximately 2033. Unrelated to mining use, gradual increases to meet local domestic use demands and other PWCC commitments for N-Aquifer water would continue under No Action after the Year 2033. These would be non-mining uses.

Community pumping from the N-Aquifer is projected to increase in the future, from 3,037 acre-feet per year in 2011 to approximately 17,595 acre-feet annually in 2110. In the No Action case, projected community pumping by the year 2057 would create the vast majority of estimated water level declines in N-Aquifer wells. Approximately 147 feet of community drawdown would occur at Kayenta, 162 feet of drawdown at the Moenkopi wellfield, 168 feet of drawdown at Low Mountain, and declines in other community wells (**Table 3.7-41**). Instead of mine-related pumping until 2057 under the Propose Action, residual PWCC effects in that year from the No Action case would range from about 14.7 feet of drawdown at Pinon to about 22.7 feet of recovery at Forest Lake. Approximately 3.2 feet of residual PWCC drawdown would occur at Kayenta, 0.01 feet at the Moenkopi wellfield, and 12.1 feet of drawdown at Low Mountain (**Table 3.7-41**). These would be negligible effects. In 2057, the increase in pumping lift (the vertical distance water would have to be pumped to the surface) due to residual PWCC effects would range from zero to 2.6 percent. These would be none to negligible effects.

With the No Action Alternative, baseflow declines in streams would largely result from projected community pumping. The most noticeable effects would be at Chinle Creek, Laguna Creek, and Polacca Wash (see **Table 3.7-17**). These would be major impacts. Simulated reductions in flow at both monitored and non-monitored springs also are predicted to result from increases in community pumping over time. Some effects would be substantial. Future effects on those flow reductions from the No Action Alternative at the proposed KMC would be negligible.

Assuming that new transmission lines would be constructed in approved ROWs, such activities would need to comply with applicable permit requirements and other agency policies and stipulations. If needed, decommissioning of the existing transmission system would proceed according to agency requirements and agreements. By doing so, impacts to water resources would be none to negligible under the No Action Alternative.

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Section 3.8

Vegetation Resources

Acronyms and Abbreviations

1969 Lease	Navajo Project Indenture of Lease
BART	Best Available Retrofit Technology
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BM&LP Railroad	Black Mesa & Lake Powell Railroad
BMPs	Best Management Practices
BO	Biological Opinion
CAP	Central Arizona Project
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CO_2	carbon dioxide
COPEC	chemical of potential ecological concern
Co-tenants	Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
Development Fund	Lower Colorado River Basin Development Fund
EIS	Environmental Impact Statement
ERA	Ecological Risk Assessment
ESA	Endangered Species Act of 1973
HHRA	Human Health Risk Assessment
HQ	Hazard quotient
km	kilometer
KMC	Kayenta Mine Complex
kV	kilovolt
kW	kilowatt
MW	megawatt
N-Aquifer	Navajo Aquifer
NEPA	National Environmental Policy Act of 1969, as amended
NGS	Navajo Generating Station
NGS Participants	U.S. (Reclamation), Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
NHPA	National Historic Preservation Act
NNEPA	Navajo Nation Environmental Protection Agency
NO_2	nitrogen dioxide
NO_X	nitrogen oxide
O&M	Operations and Maintenance
OSMRE	Office of Surface Mining Reclamation and Enforcement
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 microns or less
PFR	Partial Federal Replacement

PWCC	Peabody Western Coal Company
Reclamation	U.S. Bureau of Reclamation
ROW	Right-of-way
SO_2	sulfur dioxide
SRP	Salt River Project Agricultural Improvement and Power District
STS	Southern Transmission System
SWReGAP	Southwest Regional Gap Analysis Project
tpy	tons per year
U.S.	United States
USEPA	U.S. Environmental Protection Agency
WTS	Western Transmission System

Contents

3.8 Vegetation Resources 3.8-1
3.8.1 Regulatory Framework 3.8-1
3.8.2 Study Area 3.8-2
3.8.2.1 Proposed Action and Action Alternatives 3.8-2
3.8.2.2 Cumulative 3.8-4
3.8.2.3 Ecological Risk Assessments – Role in Assessing Baseline Risk and Environmental Consequences 3.8-4
3.8.3 Affected Environment 3.8-4
3.8.3.1 Region-wide Vegetation Resources 3.8-4
3.8.3.2 Navajo Generating Station 3.8-7
3.8.3.3 Proposed Kayenta Mine Complex 3.8-10
3.8.3.4 Transmission Systems and Communication Sites 3.8-14
3.8.4 Environmental Consequences 3.8-19
3.8.4.1 Issues 3.8-19
3.8.4.2 Assumptions and Impact Methodology 3.8-19
3.8.4.3 Proposed Action 3.8-21
3.8.4.4 Natural Gas Partial Federal Replacement Alternative 3.8-27
3.8.4.5 Renewable Partial Federal Replacement Alternative 3.8-30
3.8.4.6 Tribal Partial Federal Replacement Alternative 3.8-33
3.8.4.7 No Action 3.8-36
3.8.5 References 3.8-37

List of Appendices

Appendix 3.8-A - State-designated Noxious Weeds – Arizona, Nevada, and Utah

List of Tables

Table 3.8-1 Relevant Statutes, Regulations, and Policies for Plant Species 3.8-1
Table 3.8-2 Noxious Weeds and Invasive Plant Species 3.8-6
Table 3.8-3 Land Cover Types and Vegetative Communities within the NGS Near-field Study Area 3.8-8
Table 3.8-4 Land Cover Types and Vegetative Communities along the BM&LP Railroad 3.8-8
Table 3.8-5 Land Cover Types and Vegetative Communities within the Proposed KMC, 2019 .... 3.8-12
Table 3.8-6 Riparian and Wetland Vegetation Cover Types Relative to Upland Areas Underlain by the N-Aquifer 3.8-14
Table 3.8-7 Major Land Cover Types and Vegetative Communities along the WTS 3.8-15
Table 3.8-8 Major Land Cover Types and Vegetative Communities along the STS 3.8-16
Table 3.8-9 Communication Sites and Surrounding Land Cover 3.8-17
Table 3.8-10 Impacts to Vegetation Communities within the Proposed KMC 3.8-22
Table 3.8-11 Emissions Reductions of Selenium, Mercury, and Arsenic Under the Natural Gas PFR Alternative 3.8-28
Table 3.8-12 Emissions Reductions of Selenium, Mercury, and Arsenic Under the Renewable PFR Alternative 3.8-31
Table 3.8-13 Emissions Reductions of Selenium, Mercury, and Arsenic Under the Tribal PFR Alternative 3.8-34

List of Figures

Figure 3.8-1 Land Cover for NGS and Proposed KMC Study Areas 3.8-3
Figure 3.8-2 Proposed KMC Vegetation Communities - 2019 .... 3.8-11
Figure 3.8-3 Proposed KMC Vegetation Communities and Planned Mining 3.8-23

3.8 Vegetation Resources

3.8.1 Regulatory Framework

Laws, regulations, and policies that directly influence vegetation management decisions for the project primarily are implemented by the Office of Surface Mining Reclamation and Enforcement (OSMRE), U.S. Fish and Wildlife Service, Navajo Nation, Hopi Tribe, Bureau of Indian Affairs (BIA), Bureau of Land Management (BLM), U.S. Forest Service, and Arizona Game and Fish Department. A summary of statutes, regulations, and policies relevant to the project are included in **Table 3.8-1**. Statues, regulations, and policies relevant to special status plant species are identified in Section 3.9, Special Status Vegetation Resources.

Table 3.8-1 Relevant Statutes, Regulations, and Policies for Plant Species

Statutes, Regulations, and Policies	Summary
Surface Mining Control and Reclamation Act of 1977	The Surface Mining Control and Reclamation Act of 1977 establishes a program for the regulation of surface mining activities and the reclamation of coal-mined lands, under the administration of the Office of Surface Mining, Reclamation and Enforcement. The law establishes minimum requirements for all coal surface mining on federal and state lands, including exploration activities and the surface effects of underground mining. Mine operators are required to minimize disturbance and adverse impacts to biological resources and achieve enhancement of these resources where practicable.
BLM Manual H-4180 and Code of Federal Regulations 4180.1	BLM Manual H-4180 sets forth policies for developing and implementing land health standards on the National System of Public Lands including technical assistance and guidance for vegetation and native and non-native plant communities.
Federal Noxious Weed Act of 1974 (7 United States Code 28909)	The Federal Noxious Weed Act of 1974 provides for the control and management of nonindigenous plant species that injure or have the potential to injure the interests of agriculture and commerce, wildlife resources, or the public health. The Act requires that each federal agency develop a management program to control undesirable plants on federal lands under the agency's jurisdiction; establish and adequately fund the program; implement cooperative agreements with state agencies to coordinate management of undesirable plants on federal lands; and establish integrated management systems to control undesirable plants targeted under cooperative agreements.
Federal Plant Protection Act of 2000	The Federal Plant Protection Act of 2000 consolidates and modernizes all major statutes pertaining to plant protection and quarantine (Federal Noxious Weed Act, Plant Quarantine Act) and permits the Animal and Plant Health Inspection Service to address all types of weed issues. It also authorized the Animal and Plant Health Inspection Service to take both emergency and extraordinary emergency actions to address incursions of noxious weeds.
Arizona Revised Statute 3-201	Arizona Revised Statute 3-201 defines "noxious weed" as any species of plant that is, or is liable to be, detrimental or destructive and difficult to control or eradicate and shall include any species that the director, after investigation and hearing, shall determine to be a noxious weed.
Clean Water Act Section 404	Section 404 of the Clean Water Act regulates the discharge of dredged or fill materials into waters of the U.S., including wetlands.
Executive Order 13112	Executive Order 13112 requires federal agencies to prevent the introduction and spread of invasive species and prohibits their authorization of actions that would be likely to cause or promote the introduction or spread of invasive species.

Table 3.8-1 Relevant Statutes, Regulations, and Policies for Plant Species

Statutes, Regulations, and Policies	Summary
Executive Order 11988 Floodplain Management	Executive Order 11988 requires that federal agencies avoid to the extent possible the long- and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative.
Executive Order 11990 Protection of Wetlands	Executive Order 11990 requires federal agencies to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in carrying out an agency's responsibilities.
Nevada Revised Statutes, Chapter 555.05	Nevada Revised Statutes Chapter 555.05 defines "noxious weed" as any species of plant which is, or is likely to be, detrimental or destructive and difficult to control or eradicate.

3.8.2 Study Area

3.8.2.1 Proposed Action and Action Alternatives

As described in Chapter 1.0, there are three main components of the Navajo Generating Station (NGS)-proposed Kayenta Mine Complex (KMC) Project: the NGS and associated facilities, the proposed KMC, and the transmission systems. To facilitate description of the affected environment and analysis of project effects, a total of six different study areas divided among the three project components have been identified to analyze impacts to general vegetation. Refer to Section 3.0 for a detailed description of these study areas. The areas are displayed on **Figure 3.8-1**. The project components and their associated study areas are listed below:

Navajo Generating Station:

- NGS Near-field study area; and
- Black Mesa & Lake Powell (BM&LP) Railroad study area.

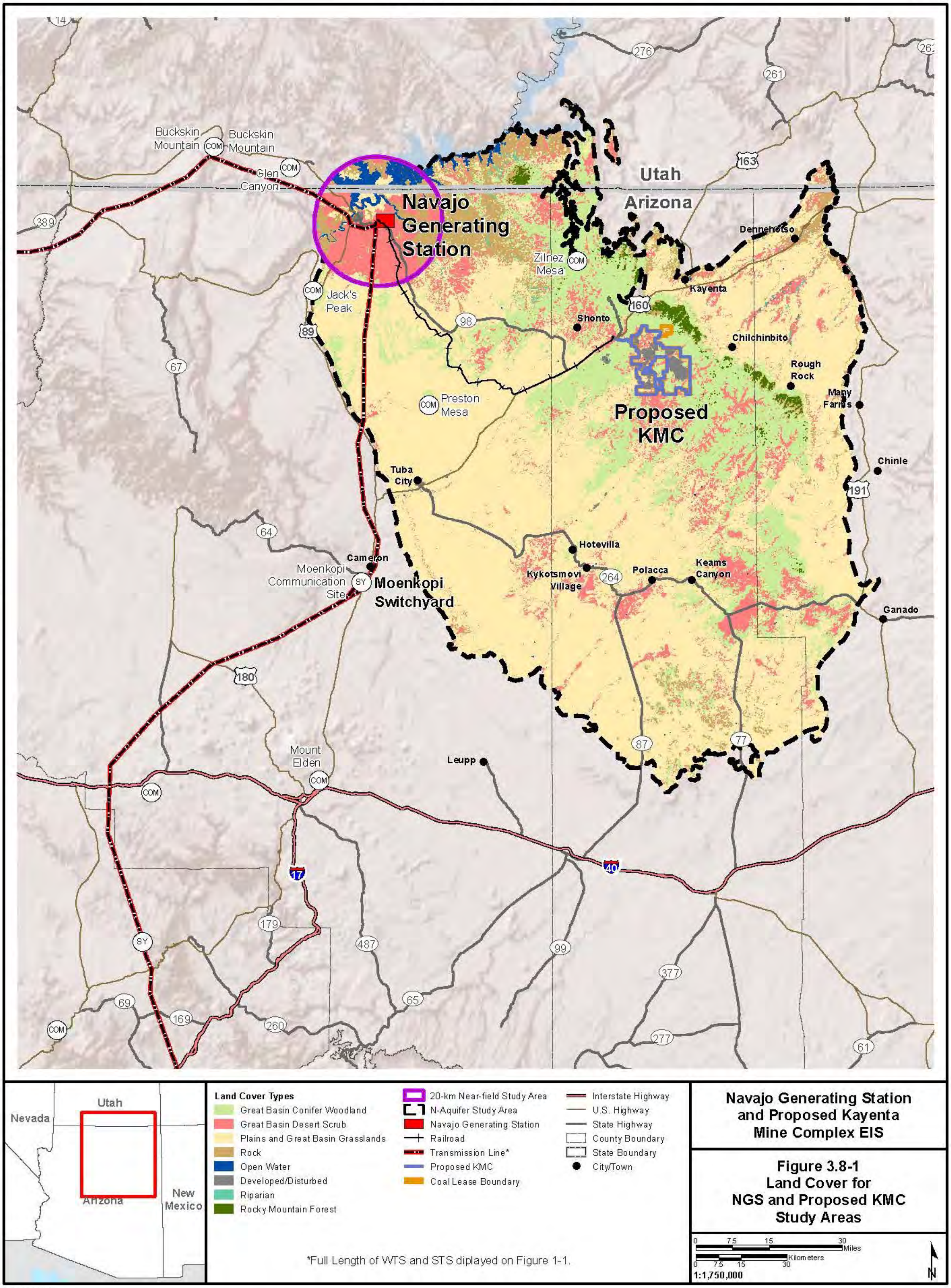
Proposed KMC:

- Proposed KMC study area; and
- Navajo Aquifer (N-Aquifer) study area.

Transmission Systems:

- Western Transmission System (WTS) study area; and
- Southern Transmission System (STS) study area.

As described in Section 3.0, potential water drawdown issues related to mine pumping at the proposed KMC was analyzed through hydrologic modeling. The study area for groundwater effects on riparian vegetation tied to seeps/springs is the same as the N-Aquifer study area as defined in Section 3.7.2, Water Resources. Because there is no new surface disturbance proposed within the N-Aquifer study area outside of the proposed KMC, impacts to upland vegetation were only analyzed in the proposed KMC disturbance area.



Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 3.8-1
Land Cover for NGS and Proposed KMC Study Areas

3.8.2.2 Cumulative

For general vegetation resources, the cumulative effects study areas are the same as those described for the Proposed Action and its alternatives. The cumulative effects analysis includes an assessment of total project affects across all study areas plus the effects of other past, present, and reasonably foreseeable actions affecting general vegetation within these areas. It should be noted that some actions assessed as part of the cumulative effects analysis may be located outside of the study areas listed above (e.g., mercury emissions associated with sources outside of the U.S.). However, to the extent that the effects of these actions combine with project-related effects to general vegetation within the six NGS-KMC study areas listed above, they are included in the cumulative effects analysis.

3.8.2.3 Ecological Risk Assessments – Role in Assessing Baseline Risk and Environmental Consequences

As detailed in Section 3.0, in order to evaluate total future risks associated with emissions from the NGS, the proposed KMC, plus other cumulative sources, it is necessary to consider the level of risk from chemicals currently present in the environment (baseline). Baseline conditions capture naturally occurring chemicals, past emission and deposition from the NGS, and past deposition from other local, regional, and global sources. The NGS Near-field ecological risk assessment (ERA) evaluated the potential risk to ecological receptors based on baseline conditions and concentrations of future NGS emission chemicals in soil, sediment, and surface water within a defined deposition area around NGS. The data used to evaluate the potential for risk to terrestrial plants was based on soil sampling results reported in the NGS Sampling Investigation Report (Ramboll Environ 2016f). Plant tissue samples were not collected or considered for the analysis. The KMC ERA prepared for the proposed KMC evaluated the potential for adverse effects to ecological receptors from exposure to chemical contaminants dispersed primarily from fugitive dust associated directly and indirectly with mining activities. Although the KMC ERA addressed risk for special status species, the potential for risk to general vegetation can be extrapolated based on the reported hazard quotients (HQs) for soils. The determination of the study area is summarized in Section 3.0.3, Ecological and Human Health Risk Assessment Approach and Study Area, and discussed in detail in **Appendix 3-RA**.

Representative species were evaluated for exposure to chemicals of potential ecological concern (COPECs). HQs were calculated for each COPEC. HQs are a ratio of estimated chemical concentrations and the appropriate ecological screening value at or below which impacts to a given species from exposure to a chemical are unlikely. The HQ is not a predictor of risk but rather is an indicator of whether or not there is a potential for risk. Detailed information on how HQs are calculated and how they are interpreted is described in **Appendix 3-RA**, Ecological and Human Health Risk Assessments. COPECs analyzed in the NGS Near-field study area analysis include inorganic chemicals (e.g., mercury and selenium) and organic chemicals, specifically dioxins/furans and polycyclic aromatic hydrocarbons.

3.8.3 Affected Environment

3.8.3.1 Region-wide Vegetation Resources

3.8.3.1.1 General Vegetation

The NGS and Kayenta Mine are located in the Colorado Plateau physiographic region. The vegetation in the Colorado Plateau is adapted to cold temperate and arid to semi-arid conditions. Major land cover types include Great Basin conifer woodland; dwarf woodland, dominated by pinyon-juniper; Great Basin desert scrub, dominated by a variety of arid land shrubs; and Plains and Great Basin grasslands, dominated by a mixture of perennial grasses and low shrubs. Other major cover types include exposed bedrock and developed/disturbed areas. Riparian/wetland areas cover only a small portion of the region and consist mostly of tamarisk shrub along major washes. Most of the region is dominated by native vegetation, with only a small portion being developed/ disturbed.

The descriptions of vegetation communities and land cover types for this analysis were based on the Southwest Regional Gap Analysis Project (SWReGAP) (U.S. Geological Survey 2005, 2004). For the purposes of SWReGAP, land cover can be characterized as natural or semi-natural vegetation and is defined by the dominant plant species. Mapping vegetation over large regions has commonly been done using imagery obtained from satellites and dividing the landscape into similar areas that correspond to land cover classes. Land cover types are divided into more detailed vegetative communities. No field verification has been performed to determine the accuracy of SWReGAP data within the project area, although approximately 93,000 field samples were collected within the region mapped by the SWReGAP project to assist the land cover modeling effort (Lowry et al. 2005).

3.8.3.1.2 Riparian/Wetlands

Riparian areas are transitional areas between aquatic and upland habitat. They have distinctive vegetation communities related to increased availability of water from occasional to regular flooding and elevated water tables. Typical riparian areas occupy lakeshores and streambanks and include vegetation such as cottonwood, tamarisk, and willow. In the arid west, these areas generally have greater vegetation cover and productivity than upland areas. Wetlands are defined under Clean Water Act Section 404 regulations as "those areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." To be identified as a wetland, areas must exhibit hydrophytic vegetation, hydric soils, and wetland hydrology (U.S. Army Corps of Engineers 1987). The Section 404 regulations also cover surface water features that have a defined bed and bank and that have connectivity to other waters of the U.S. Projects that directly affect waters of the U.S., including wetlands, require permitting under Section 404 of the Clean Water Act.

3.8.3.1.3 Noxious Weeds and Invasive Species

Legally, noxious weeds are defined as any plant designated by a federal, state, or county government as injurious to public health, agriculture, recreation, wildlife, or property. Invasive species have similar ecological effects as noxious weeds but are not covered by existing regulations in the NGS-KMC Project area. Both noxious weeds and invasive species can out-compete native vegetation in areas of disturbance and can spread quickly in a short timeframe.

The Federal Noxious Weed Act of 1974 (7 United States Code 28909) established a nationwide definition of noxious weeds. The Arizona Department of Agriculture, Nevada Department of Agriculture, Utah Department of Agriculture and Food, BIA, and federal land management agencies (BLM, U.S. Forest Service) all have requirements for management of noxious weeds.

The State of Arizona designates noxious weeds under Arizona Revised Statute 3-201. Weeds that are not indigenous to the state and likely to be detrimental, destructive, and difficult to control or eradicate may be listed as noxious by the state. Arizona-listed weeds are classified into prohibited, regulated, and restricted weeds. Prohibited species are quarantined from entry into the state. Regulated species means that any visible plant parts may be controlled to prevent further infestation. Restricted means that any viable plant parts found within the state shall be quarantined to prevent further infestation. The Arizona noxious weed list is included in **Appendix 3.8-A**.

The State of Nevada designates noxious weeds under the Nevada Revised Statute, Chapter 555.05. Nevada-listed weeds are classified into Category A, Category B, and Category C. Category A weeds are generally not found or are limited in distribution throughout the state. Category B weeds are generally established in scattered populations in some counties in the state. Category C weeds are generally established and widespread in many counties. Each category has guidelines for management and/or eradication. The Nevada noxious weed list is included in **Appendix 3.8-A**.

The State of Utah designates noxious weeds under Section 4.17-3, the Utah Noxious Weed Act. Utah-listed weeds are classified as Class A, Class B, and Class C. Class A weeds are "Early Detection Rapid

Response" declared weeds that are not native to Utah, pose a serious threat, and should be considered a high priority for treatment/removal. Class B weeds are not native to Utah, pose a threat to the state, and are considered a high priority for control. Class C weeds are not native to the state, are widely spread, and pose a threat to the agricultural industry. The focus on Class C weeds is to contain them, and thus help prevent spread. The Utah noxious weed list is included in **Appendix 3.8-A**.

The BIA Navajo Region currently is developing an integrated noxious weed management plan (BIA 2015) and the Navajo Region maintains a Noxious/Invasive Weed List, which is provided in **Appendix 3.8-A**.

Table 3.8-2 provides a list of noxious weeds that may occur within the area for each of the project components. Based on mapped distributions and habitats present, several species of noxious weeds and invasive plant species may occur at each of the facilities.

Table 3.8-2 Noxious Weeds and Invasive Plant Species

Species	Arizona Weed Category	Known or Potential Occurrence[1]				
		NGS and Associated Facilities	BM&LP Railroad	Proposed KMC	WTS	STS
Arizona Noxious Weeds						
Buffelgrass *Pennisetum ciliare*	Prohibited Regulated					Possible
Camelthorn *Alhagi pseudoalhagi*	Regulated Restricted		Possible		Possible	Likely
Common purslane *Portulaca oleracea*	Prohibited Regulated	Possible	Possible	Known	Possible	Possible
Dalmatian toadflax *Linaria genistifolia* var. *dalmatica*	Prohibited Restricted				Possible	
Diffuse knapweed *Centaurea diffusa*	Prohibited Restricted		Possible	Known		
Dodder *Cuscuta* spp.	Prohibited				Possible	Possible
Field bindweed *Convolvulus arvensis*	Prohibited Regulated	Possible	Known	Known	Likely	Likely
Halogeton *Halogeton glomeratus*	Prohibited Restricted	Possible	Possible	Known	Likely	Possible
Jointed goatgrass *Aegilops cylindrica*	Prohibited Restricted				Possible	
Puncture vine *Tribulus terrestris*	Prohibited Regulated	Possible	Known	Known	Possible	Possible
Quackgrass *Elytrigia repens*	Prohibited Restricted				Possible	Possible
Russian knapweed *Acroptilon repens*	Prohibited Restricted	Possible	Known	Known	Likely	Likely
Scotch thistle *Onorpordum acanthium*	Prohibited Restricted	Possible	Known	Known	Known	Possible

Table 3.8-2 Noxious Weeds and Invasive Plant Species

Species	Arizona Weed Category	Known or Potential Occurrence[1]				
		NGS and Associated Facilities	BM&LP Railroad	Proposed KMC	WTS	STS
Yellow starthistle *Centaurea solstialis*	Prohibited Restricted				Possible	Possible
Other Invasive Species						
African mustard *Brassica tournefortii*	NA				Known	Likely
Black henbane *Hyoscyamus niger*	NA				Likely	
Bull thistle *Cirsium vulgare*	NA		Known	Known	Possible	Possible
Cheatgrass *Bromus tectorum*	NA	Likely	Likely	Known	Known	Likely
Kochia *Bassia scoparia*	NA	Likely	Known	Known	Likely	Likely
Malta starthistle *Centaurea melitensis*	NA				Likely	
Musk thistle *Carduus nutans*	NA		Known	Known	Possible	
Red brome *Bromus rubens*	NA				Known	
Russian olive *Elaeagnus angustifolia*	NA			Possible	Possible	
Prickly Russian thistle *Salsola tragus*	NA	Likely	Likely	Known	Likely	Likely
Tamarisk (salt cedar) *Tamarix* spp.	NA	Possible	Likely	Known	Known	Likely

[1] Center for Invasive Species and Ecosystem Health 2015; Howery 2009; OSMRE 2011, 2008.

NA = Not applicable.

3.8.3.2 Navajo Generating Station

3.8.3.2.1 General Vegetation

Major land cover types and vegetative communities found within the NGS Near-field study area (i.e., within a 20-kilometer [km] radius of the power plant) are listed in **Table 3.8-3**. Those found along the existing BM&LP Railroad are provided in **Table 3.8-4**. The distribution of these land cover types is shown on **Figure 3.8-1**. Based on the NGS Near-field ERA results, the maximum HQs for baseline (current) conditions were all below 1, indicating that there would be no effect to vegetation communities under baseline conditions.

Table 3.8-3 Land Cover Types and Vegetative Communities within the NGS Near-field Study Area

Land Cover Types	Vegetative Communities Associated with Land Cover Types: SWReGAP	Acres	Percent
Great Basin Conifer Woodland	Colorado Plateau Pinyon-juniper Woodland Colorado Plateau Pinyon-juniper Shrubland	10,295	2.9
Great Basin Desert Scrub	Colorado Plateau Blackbrush-Mormon Tea Shrubland Intermountain Basins Big Sagebrush Shrubland Intermountain Basins Greasewood Flat Intermountain Basins Mixed Salt Desert Scrub	159,211	45.3
Plains and Great Basin Grasslands	Intermountain Basins Active and Stabilized Dunes Intermountain Basins Semi-desert Grassland Intermountain Basins Semi-desert Shrub Steppe Colorado Plateau Sand Shrubland	48,714	13.8
Riparian	Invasive Southwest Riparian Woodland and Shrubland North American Warm Desert Riparian Woodland and Shrubland	1,331	0.4
Rock	Colorado Plateau Mixed Bedrock Canyon and Tableland	83,324	23.7
Water	Open Water	43,774	12.5
Developed/Disturbed	Developed, Medium – High Intensity Developed, Open Space – Low Intensity	5,041	1.4
No data[1]		51	<0.1
Total[2]		**351,741**	**100**

[1] Small areas are present that were not mapped by SWReGAP.
[2] Totals may differ due to rounding.
Source: SWReGAP (U.S. Geological Survey 2004).

Table 3.8-4 Land Cover Types and Vegetative Communities along the BM&LP Railroad

Land Cover Types	Vegetative Communities Associated with Land Cover Types	Acres[1]	Percent
Great Basin Conifer Woodland	Colorado Plateau Pinyon-juniper Woodland Intermountain Basins Juniper Savanna	534	11.8
Great Basin Desert Scrub	Intermountain Basins Big Sagebrush Shrubland Colorado Plateau Blackbrush-Mormon Tea Shrubland	1,387	30.6
Plains and Great Basin Grasslands	Intermountain Basins Semi-desert Shrub Steppe Southern Colorado Plateau Sand Shrubland	2,377	52.4
Riparian	None	0	0.0
Rock	Colorado Plateau Mixed Bedrock Canyon and Tableland	50	1.1
Water	Open Water	0	0.0
Developed/Disturbed	Developed, Open Space – Low Intensity	188	4.1
Total[2]		**4,536**	**100.0**

[1] Based on a 250-foot buffer.
[2] Totals may differ due to rounding.
Source: SWReGAP (U.S. Geological Survey 2004).

Great Basin conifer woodland is found in approximately 2.9 percent of the NGS Near-field study area and includes two vegetative communities - Colorado Plateau pinyon-juniper woodland and pinyon-juniper shrubland. Great Basin conifer woodlands occur in Arizona at elevations of 3,400 to 8,800 feet above mean sea level (amsl) (Arizona Game and Fish Department 2012). Pinyon pine (*Pinus edulis*) and Utah juniper (*Juniperus osteosperma*) are the common tree species. Common understory shrubs include big sagebrush (*Artemisia tridentata*), four-wing saltbush (*Atriplex canescens*), Mexican cliffrose (*Purshia mexicana*), Douglas rabbitbrush (*Chrysothamnus viscidiflorus*), and rubber rabbitbrush (*Ericameria nauseosa*) (Brown 1982). Grasses and forbs provide a small amount of cover with the most common of these being bottlebrush squirreltail (*Elymus elymoides* ssp. *elymoides*), Indian ricegrass (*Acnatherum hymenoides*), and muttongrass (*Poa fendleriana*) (Brown 1994).

Great Basin desert scrub is found in approximately 45.3 percent of the NGS Near-field study area and is the most common land cover type. It includes four vegetative communities - Colorado Plateau blackbrush-Mormon tea shrubland, intermountain basins big sagebrush shrubland, intermountain basins greasewood flat, and intermountain basins mixed salt desert scrub. Great Basin desert scrub occurs at elevations of 3,000 to 6,500 feet amsl in Arizona (Arizona Game and Fish Department 2012). Vegetation is dominated by low-growing, small-leaved grasses and shrubs including blue grama (*Bouteloua gracilis*), saltgrass (*Distichlis spicata*), needle-and-thread (*Hesperostipa comata*), big sagebrush, shadscale (*Atriplex confertifolia*), blackbrush (*Coleogyne ramosissima*), Mormon tea (*Ephedra viridis* and *E. torreyana*), greasewood (*Sarcobatus vermiculatus*), four-wing saltbush, and rubber rabbitbrush.

Plains and Great Basin grassland is found in approximately 13.8 percent of the NGS Near-field study area and includes four vegetative communities - intermountain basins active and stabilized dunes, intermountain basins semi-desert grassland, intermountain basins semi-desert shrub steppe, and Colorado Plateau sand shrubland. Plains and Great Basin grassland cover occur in Arizona from 5,000 to 7,000 feet amsl. This is a perennial grass-dominated landscape with short- or mid-height grasses, including blue grama, sideoats grama (*Bouteloua curtipendula*), buffalo-grass (*Buchloe dactyloides*), Indian rice grass, galletagrass (*Hilaria jamesii*), prairie junegrass (*Koeleria macrantha*), alkali sacaton (*Sporobolus airoides*), and others. Shrubs are common, including four-wing saltbush, big sagebrush, winterfat (*Krascheninnikovia lanata*), rabbitbrush, and prickly pear cactus (*Opuntia* spp.).

The rock land cover type is found within approximately 23.7 percent of the NGS-Near-field study area. The only vegetative community within this land cover type is Colorado Plateau mixed bedrock canyon and tableland. This cover type includes barren and sparsely vegetated landscapes on cliffs, canyons, and open tablelands of mostly sedimentary rocks. The vegetation includes scattered trees and shrubs with a sparse herbaceous layer. Common species include pinyon pine, ponderosa pine (*Pinus ponderosa*), Utah juniper, and dwarf mountain mahogany (*Cercocarpus intricatus*).

Open water is found within approximately 12.5 percent of the NGS Near-field study area and is largely comprised of Lake Powell and the Colorado River.

Developed/disturbed lands occupy approximately 1.4 percent of the NGS Near-field study area and include two communities - medium to high intensity development and low intensity open space development. The NGS plant site includes several associated facilities such as the ash disposal area and road, pump station, pump station road, and buried pipeline/powerline that contribute to this category. The town of Page also is included in this land cover type (U.S. Geological Survey 2004).

Land cover types and vegetative communities found along the existing BM&LP Railroad are provided in **Table 3.8-4**. More than half the land cover type found along the BM&LP Railroad consists of plains and Great Basin grassland. About 30 percent of the remaining land cover is Great Basin desert scrub.

3.8.3.2.2 Riparian/Wetlands

Riparian areas consist of vegetation along rivers and streams and around impoundments that are influenced by flooding and/or high groundwater levels. Riparian areas are found within approximately 0.4 percent of the NGS Near-field study area and include two vegetative communities - invasive southwest riparian woodland and shrubland and warm desert riparian woodland and shrubland. The invasive riparian woodland and shrubland is dominated by tamarisk. Warm desert riparian woodland and shrubland typically occurs as a tree-dominated community of cottonwoods and willows (*Salix* spp.) with a diverse shrub understory (U.S. Geological Survey 2005).

Based on available information, there are no riparian or wetland areas in the immediate vicinity of the NGS plant site or associated facilities. The lake pump station is located at the edge of Lake Powell, which is a water of the U.S. under the jurisdiction of Section 404 of the Clean Water Act. The drainage that crosses the northeast corner of the NGS plant site is a tributary of Lake Powell and also may be a water of the U.S.

Riparian vegetation is scarce at Lake Powell due to continuously fluctuating lake levels and upland desert vegetation extending to the water's edge (U.S. Bureau of Reclamation 2007). Below the dam, riparian communities are dominated by tamarisk, arrowweed (*Pluchea sericea*), Gooding willow (*Salix goodingii*), coyote willow (*Salix exigua*), bulrush (*Scirpus acutus*), and Emery seepwillow (*Baccharis emoryi*) (Reclamation 2007).

No riparian/wetlands are present along the BM&LP Railroad (U.S. Geological Survey 2004). However, aerial photographs show that 2 to 3 acres of tamarisk (Invasive Southwest Riparian Woodland and Shrubland) are present at the crossing of Begashibito Wash outside of the 250-foot analysis buffer.

3.8.3.2.3 Noxious Weeds and Invasive Species

No specific information is available on noxious weed occurrence at the NGS plant site and its facilities. Based on mapped distributions and habitats present, several species of noxious weeds and invasive plant species are possible or likely to occur at the NGS plant site and associated facilities as noted in **Table 3.8-2**.

A number of noxious weeds and invasive plant species are known or likely to occur along the BM&LP Railroad as noted in **Table 3.8-2**. Noxious weeds known along the rail corridor include puncture vine, Russian knapweed, and Scotch thistle. Invasive plant species known to occur along the railroad include bull thistle, kochia, and musk thistle.

3.8.3.3 Proposed Kayenta Mine Complex

3.8.3.3.1 General Vegetation

Vegetation communities within the proposed KMC are displayed on **Figure 3.8-2**. Detailed vegetation studies, including baseline vegetation sampling of the coal resource areas and reference areas, were conducted between 1979 and 1983, and supplemental baseline sampling has been performed at various times since then (ESCO Associates and Peabody Western Coal Company [PWCC] 2003; OSMRE 2011). A vegetation map used in the 2011 Kayenta Mine Environmental Assessment (OSMRE 2011) as well as aerial interpretation of 2014 GoogleEarth® imagery further refined the vegetative communities displayed within the proposed KMC.

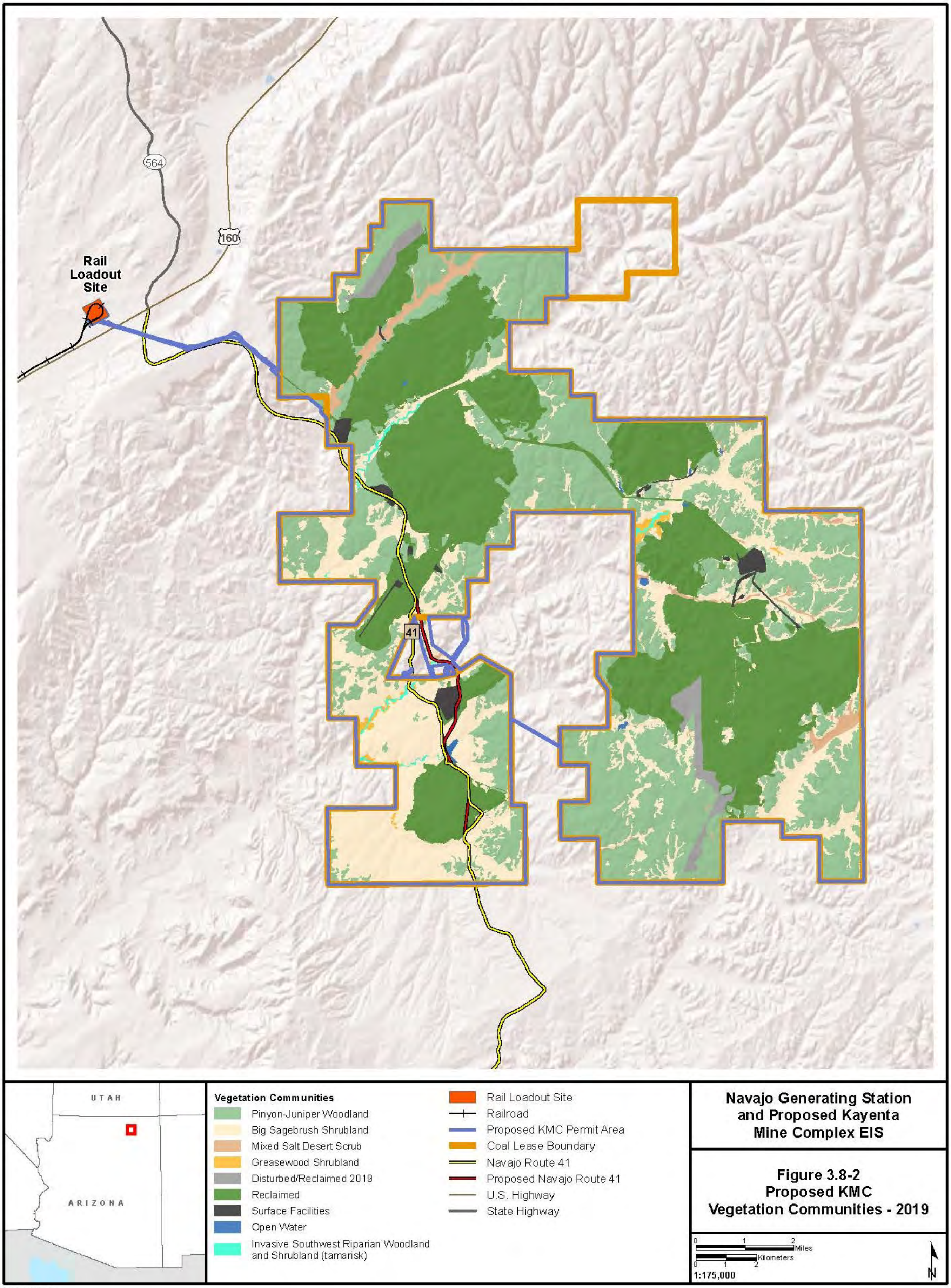


Figure 3.8-2
Proposed KMC
Vegetation Communities - 2019

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7/20/2016

Table 3.8-5 provides a summary of baseline (2019) acreages of the land cover types and vegetative communities within the proposed KMC. The land cover types of the proposed KMC are primarily Great Basin conifer woodland, Great Basin desert scrub, and recently mined areas. There are smaller areas of riparian and open water.

Table 3.8-5 Land Cover Types and Vegetative Communities within the Proposed KMC, 2019

Land Cover Types	Vegetative Communities Associated with Land Cover Types	Acres	Percent
Great Basin Conifer Woodland	Colorado Plateau Pinyon-juniper Woodland	23,557	37.5
Great Basin Desert Scrub	Intermountain Basins Big Sagebrush Shrubland	13,161	20.9
	Intermountain Basins Mixed Salt Desert Scrub	981	1.6
	Intermountain Basins Greasewood Shrubland	244	<1.0
Riparian	Invasive Southwest Riparian Woodland and Shrubland (tamarisk)	230	<1.0
Water	Open Water	87	<1.0
Developed/Disturbed	Disturbed/Reclaimed[1]	979	<1.0
	Reclaimed	22, 826	37.7
	Facilities	770	1.2
Total[2]		62,835	100.0

[1] Disturbed/reclaimed represents areas that are currently disturbed but likely to be reclaimed by 2019.

[2] Totals may differ due to rounding. Approximately 87 acres (0.1 percent) were not assigned a land cover type and are not included in table totals.

Source: U.S. Geological Survey 2004.

The Great Basin conifer woodland occurs on approximately 38 percent of the proposed KMC. The composition of this land cover type is described in Section 3.8.3.2, Navajo Generating Station.

Great Basin desert scrub occupies approximately 23 percent of the proposed KMC and more than 90 percent of this is sagebrush shrubland. This vegetative community occurs on deeper soils that develop in flatter areas and valley bottoms. Total vegetation cover is often less than 20 percent, with low rock cover and sparse understory vegetation. Sagebrush shrubland is the most prevalent vegetation type below 7,000 feet amsl on Black Mesa. Above that elevation, it is interspersed with pinyon-juniper woodland. Sagebrush shrubland is dominated by big sagebrush and blue grama. Common shrub species include four-wing saltbush, Douglas rabbitbrush, Greene's rabbitbrush (*Chrysothamnus greenei*), and rubber rabbitbrush. Common grasses include galletagrass, bottlebrush squirreltail, big squirreltail (*Sitanion jubatum*), needle-and-thread, Indian ricegrass, and western wheatgrass (*Elymus smithii*) (ESCO Associates, Inc. and PWCC 2003).

Two other Great Basin desert scrub vegetative communities occur in the area. Mixed salt desert scrub and greasewood occupy relatively small, linear areas along washes in the proposed KMC and occur on the margins of terraces associated with the higher order drainages. The terraces typically lie 5 to 20 feet above wash channels where saline alluvial soil has accumulated. Four-wing saltbush dominates the saltbush community and greasewood dominates the greasewood community (Brown 1994). Annual forbs and grasses form sparse to dense understories (ESCO Associates, Inc. and PWCC 2003).

Developed/disturbed areas within the proposed KMC consist mostly of active and recently mined lands, reclaimed lands, and areas occupied by facilities. These areas comprise nearly 40 percent of the analysis area. Reclaimed areas are designed to achieve vegetation communities that support livestock grazing, wildlife habitat, and cultural plants. Native and introduced grasses and native shrubs dominate reclaimed lands in the proposed KMC. Cool-season native grass species include western wheatgrass, thickspike wheatgrass (*Elymus lanceolatus*), Indian ricegrass, needle-and-thread, big squirreltail, and bottlebrush squirreltail; and common warm-season native grass species include blue grama, galletagrass, and alkali sacaton. The most abundant introduced perennial grass species is Russian wildrye (*Elymus junceus*). Crested wheatgrass (*Agropyron desertorum*) and intermediate wheatgrass (*Agropyron intermedium*) also are present. Four-wing saltbush is the dominant shrub species, but several other species are common. Several weedy annuals primarily occur in newer reclamation areas. These include kochia, prickly Russian thistle, and cheatgrass (ESCO Associates, Inc. and PWCC 2003; OSMRE 2011). The purpose of reclamation is to restore the affected lands to the approximate landforms that existed prior to mining and to establish an effective and permanent vegetative cover similar in seasonal variety, diversity, and plant composition to the native vegetation found on undisturbed lands surrounding the mining operation. PWCC has established the following reclamation goals: manage reclaimed areas to meet reclamation standards; use grazing to remove standing dead vegetative litter and promote new growth and aid in establishing new seedlings; and demonstrate the utility of reclaimed lands for various seasons of use. For more information concerning reclamation, see Section 3.14.2.3, Land Use, Proposed Kayenta Mine.

Approximately 87 acres within the proposed KMC is open water made up of water impoundments, many of which are permanent. Smaller impoundments including sediment ponds and internally draining ponds in reclaimed areas are not included in this acreage. Some of the larger impoundments have shrubs and emergent wetland plants along the margin, including tamarisk, coyote willow, bulrush, and cattail (*Typha latifolia*). Submergent aquatic plants include common poolmat (*Zanichellia palustris*), pondweeds (*Potamogeton filiformis* and *P. pectinata*), and holly-leafed water nymph (*Najas marina*). The only non-microscopic alga found in most ponds is green algae (*Chara* spp.).

Numerous species of native plants found in the proposed KMC have cultural significance to the Hopi and Navajo people for use as food or medicine, use in rituals, and other uses such as tools, construction, and baskets. Lists of these plants are kept by the Hopi and Navajo based on published information about such uses (Mayes and Lacy 2012). Approximately 475 acres of cultural plant sites have been established since 1994 on select sites within reclamation areas at the proposed KMC. These are developed in areas with a mesic aspect and on coarse-textured skeletal soils and rocky substrates similar to native areas supporting pinon-juniper woodland and historic cultural collection sites. These sites, combined with native shrubland and pinon-juniper planting areas, will comprise approximately 5 percent of the reclaimed lands (OSMRE 2011).

3.8.3.3.2 Riparian/Wetlands

Riparian vegetation is less than 1 percent of the proposed KMC and occurs along major drainages, forming linear bands of vegetation. Riparian areas are typically between 10 and 20 feet wide and from a few yards to more than 0.5-mile-long. This vegetation occurs on the bottoms of washes and typically occupies the depositional side of a channel. Within the proposed KMC, surface water in riparian areas usually is ephemeral (only exists for a short time after precipitation), but short reaches of intermittent streams are present. Tamarisk is the dominant species among the riparian vegetation. Small amounts of greasewood and four-wing saltbush are common with tamarisk in drier areas. Coyote willow occurs with tamarisk in wetter areas. Herbaceous understory vegetation is limited and often is composed of cheatgrass, European alkali grass (*Puccinellia distans*), stickseed (*Lappula occidentalis*), and desert seepweed (*Suaeda torreyana*) (ESCO Associates, Inc. and PWCC 2003; OSMRE 2011).

Small tamarisk-dominated riparian areas are present in the southwest portion of the proposed KMC along lower Moenkopi Wash, Red Peak Valley Wash, and Coal Mine Wash. Small areas of wetlands also are present at some ponds. The major drainages in the proposed KMC are waters of the U.S. under the jurisdiction of Section 404 of the Clean Water Act; however, the active mine areas are located outside these drainages.

Table 3.8-6 provides a summary of riparian vegetation underlain by the N-Aquifer. Most of the riparian woodland and shrubland communities are located along the lower portions of major washes, including Begashibito Wash, Moenkopi Wash, Dinnebito Wash, Oraibi Wash, Polacca Wash, Jeddito Wash, and Chinle Wash. Within the N-Aquifer, riparian/wetland areas were identified through a Geographic Information System analysis using SWReGAP data, LANDFIRE data, and aerial photo interpretation. Woodland riparian communities identified through aerial photo interpretation within Spring Groups that could be affected by water pumping (Spring Groups D, F1, and I) were prioritized and added to the total riparian acreage number within the N-Aquifer study area. Section 3.7, Water Resources, contains detailed information concerning the spring groups. Upland vegetation was not assessed within the N-Aquifer study area outside of the proposed KMC disturbance area.

Table 3.8-6 Riparian and Wetland Vegetation Cover Types Relative to Upland Areas Underlain by the N-Aquifer

Land Cover Types	Vegetative Communities Associated with Land Cover Types	Acres	Percent
Riparian	Invasive Southwest Riparian Woodland and Shrubland (SWReGAP)	2,708	0.04
	Rocky Mountain Lower Montane Woodland and Shrubland (SWReGAP)	133	less than 0.01
	Riparian (LANDFIRE)	22,209	0.33
	Riparian (desktop aerial interpretation)	555	less than 0.01
Water	Open water	24,560	0.37
Uplands	—	6,602,430	99.25
Total		6,652,595	100.00

Source: U.S. Geological Survey 2004.

3.8.3.3.3 Noxious Weeds and Invasive Species

A number of noxious weed or invasive plant species are known or expected to occur within the proposed KMC and are summarized in **Table 3.8-2**. Known noxious weeds include common purslane, diffuse knapweed, field bindweed, halogeton, puncture vine, Russian knapweed, tamarisk, and Scotch thistle. Weedy invasives known to occur in the proposed KMC include bull thistle, kochia, musk thistle, prickly Russian thistle, cheatgrass, and tamarisk (Center for Invasive Species and Ecosystem Health 2015; ESCO Associates and PWCC 2003; U.S. Geological Survey 2004). At the proposed KMC, several of the invasive species are early successional weedy species found in newly reclaimed and disturbed areas that diminish as perennial vegetation develops and out-competes these species (OSMRE 2011). The PWCC vegetation management program monitors and treats annual weeds.

3.8.3.4 Transmission Systems and Communication Sites

3.8.3.4.1 General Vegetation

The WTS extends from NGS west to the Mojave Desert and Great Basin in southern Nevada. The eastern portions of the WTS cross vegetation typical of the Colorado Plateau including Great Basin conifer woodland and desert scrub. The western portion crosses Mojave Desert scrub.

The STS extends south from the cold deserts of the Colorado Plateau to the northern part of the Sonoran Desert north of Phoenix, Arizona. Nearly 50 percent of the land cover present along the STS is conifer woodland and grasslands.

Tables 3.8-7 and **3.8-8** provide summaries of the land cover types and vegetation communities along the WTS and STS, respectively, based on SWReGAP (U.S. Geological Survey 2004). A buffer-width of

2 miles (1 mile on each side) was used to determine the major land cover types and vegetative communities near the transmission systems. This does not mean all of these areas were impacted. The WTS is less diverse and mostly crosses desert scrub habitat. The STS has a diverse range of vegetative communities because it crosses mountainous areas and mid-elevation areas in central Arizona before dropping down into the Sonoran Desert. The power line corridors were constructed and built approximately 40 years ago, and vegetation within the right-of-way (ROW) corridor has been maintained to support low growing grasses, herbaceous species, and shrubs.

Table 3.8-7 Major Land Cover Types and Vegetative Communities along the WTS

Land Cover Types	Vegetative Communities Associated with Land Cover Types	Acres[1]	Percent
Great Basin Conifer Woodland	Colorado Plateau Pinyon-juniper Woodland Colorado Plateau Pinyon-juniper Shrubland	23,191	6.6
Great Basin Desert Scrub	Colorado Plateau Blackbrush-Mormon tea Shrubland Intermountain Basins Big Sagebrush Shrubland Intermountain Basins Greasewood Flat Intermountain Basins Mixed Salt Desert Scrub	90,985	25.8
Plains and Great Basin Grasslands	Intermountain Basins Semi-desert Grassland Intermountain Basins Semi-desert Shrub Steppe Intermountain Basins Active and Stabilized Dune Invasive Annual Grassland Invasive Annual and Biennial Forbland Intermountain Basins Mat Saltbush Shrubland	27,716	7.8
Mohave Desert Scrub	Mojave Mid-elevation Mixed Desert Scrub	13,011	3.7
Sonoran-Mojave Desert Scrub	Sonoran-Mojave Creosotebush-White Bursage Desert Scrub Sonoran-Mojave Mixed Salt Desert Scrub North American Warm Desert Wash	166,237	47.0
Riparian	Invasive Southwest Riparian Woodland and Shrubland North American Warm Desert Playa	1,817	0.5
Rock	Colorado Plateau Mixed Bedrock Canyon and Tableland North American Warm Desert Badland North American Warm Desert Bedrock Cliff and Outcrop North American Warm Desert Pavement North American Warm Desert Volcanic Rockland	25,652	7.3
Water	Open Water	279	0.1
Developed/Disturbed	Agriculture Developed, Medium – High Intensity Developed, Open Space – Low Intensity	3,669	1.0
No Data[2]	—	755	0.2
Total[3]		353,342	100.0

1 Acres based on 2-mile-wide corridor centered on transmission line.
2 Small areas are present that were not mapped by SWReGAP.
3 Totals may differ due to rounding.
Source: SWReGAP (U.S. Geological Survey 2004).

Table 3.8-8 Major Land Cover Types and Vegetative Communities along the STS

Land Cover Types	Vegetative Communities Associated with Land Cover Types	Acres[1]	Percent
Great Basin Conifer Woodland	Colorado Plateau Pinyon-juniper Woodland Intermountain Basins Juniper Savanna	73,809	21.9
Great Basin Desert Scrub	Colorado Plateau Blackbrush-Mormon Tea Shrubland Intermountain Basins Big Sagebrush Shrubland Intermountain Basins Greasewood Flat Intermountain Basins Mixed Salt Desert Scrub	51,749	15.4
Plains and Great Basin Grasslands	Intermountain Basins Semi-Desert Grassland Intermountain Basins Semi-Desert Shrub Steppe Intermountain Basins Shale Badland Southern Colorado Plateau Sand Shrubland Intermountain Basins Active and Stabilized Dune	80,301	23.9
Semi-desert Grassland	Apacherian-Chihuahuan Piedmont Semi-desert Grassland and Steppe	13,426	4.0
Mogollon Chaparral	Mogollon Chaparral	16,112	4.8
Madrean Conifer Woodland	Madrean Pinyon-Juniper Woodland Madrean Pine-oak Forest and Woodland Madrean Juniper Savanna	24,656	7.3
Upland Sonoran Desert Scrub	Sonoran Paloverde – Mixed Cacti Desert Scrub	33,933	10.1
Sonoran-Mojave Desert Scrub	Sonoran-Mojave Creosotebush-White Bursage Desert Scrub Sonoran Mid-Elevation Desert Scrub	9,110	2.7
Chihuahuan Desert Scrub	Apacherian-Chihuahuan Mesquite Upland Shrub	16,584	4.9
Rocky Mountain Forest	Rocky Mountain Ponderosa Pine Woodland	4,243	1.3
Riparian	Invasive Southwest Riparian Woodland and Shrubland North American Warm Desert Lower Montane Riparian Woodland and Shrubland North American Warm Desert Riparian Woodland and Shrubland	1,580	0.5
Rock	Colorado Plateau Mixed Bedrock Canyon and Tableland	7,077	2.1
Water	Open Water	26	0.0
Developed/Disturbed	Developed, Medium – High Intensity Developed, Open Space – Low Intensity Agriculture	3,275	1.0
No Data[2]		633	0.2
Total[3]		336,517	100.0

[1] Acres based on 2-mile-wide corridor centered on transmission line.

[2] Small areas are present that were not mapped by SWReGAP.

[3] Totals may differ due to rounding.

Source: SWReGAP (U.S. Geological Survey 2004).

Table 3.8-9 displays the communication sites and the surrounding land cover type. Past development of these communication sites likely impacted the general vegetation community that currently surrounds each site.

Table 3.8-9 Communication Sites and Surrounding Land Cover

Communication Site	Land Cover Type[1]
Preston Mesa	Great Basin Conifer Woodland
Jack's Peak	Great Basin Desert Scrub
Zilnez Mesa	Great Basin Conifer Woodland
Red Mountain	Rock
Apex to Crystal	Rock
Glendale	Great Basin Desert Scrub
Beaver Dam	Great Basin Conifer Woodland
Pipe Springs	Great Basin Conifer Woodland
Buckskin Mountain	Great Basin Desert Scrub
Glen Canyon	Great Basin Desert Scrub
Mt. Elden	Plains and Great Basin Grassland
Bill Williams	Rocky Mountain Forest
Mingus Mountain	Rocky Mountain Forest
Mt. Francis	Rocky Mountain Forest
West Wing	Developed/Disturbed
White Tank	Mogollon Chaparral
West Phoenix	Developed/Disturbed

[1] Based on SWReGAP data.

Descriptions of Great Basin conifer woodland, Great Basin desert scrub, and Plains and Great Basin grassland land cover types are provided under Section 3.8.3.2, Navajo Generating Station.

Mojave Desert scrub occurs along the WTS and represents approximately 3.7 percent of the land cover. The vegetative community represented by this land cover is Mojave mid-elevation mixed desert scrub. In the analysis area, it is a transitional habitat above the Sonoran-Mojave Desert scrub and below Lower Montane woodlands. It is a shrubland dominated by a variable group of species including blackbrush, eastern Mojave buckwheat (*Eriogonum fasciculatum*), Nevada jointfir (*Ephedra nevadensis*), spiny hopsage, and yuccas (*Yucca breviolia* and *Y. schidigera*).

Sonoran-Mojave Desert scrub represents approximately 47.0 percent of the WTS and 2.7 percent of the STS. Three vegetative communities are represented by this land cover along the WTS - Sonoran-Mojave creosotebush-white bursage desert scrub, mixed salt desert scrub, and warm desert wash. Two vegetative communities represent this land cover along the STS - Sonoran-Mojave creosotebush-white bursage desert scrub and Sonoran mid-elevation desert scrub. Sonoran-Mojave desert scrub is a low-growing, open shrubland dominated by creosote bush, white bursage, and burrobush (*Ambrosia dumosa*), with a number of other shrub species common including shadscale and brittlebush. Herbaceous plants are scarce during most seasons but may be locally abundant after rains. This community occurs in arid areas up to 5,500 feet amsl.

Rock is present as a land cover along the WTS and STS and can support a variety of vegetative communities including Colorado Plateau mixed bedrock canyon and tableland, North American warm desert badland, warm desert bedrock cliff and outcrop, warm desert pavement, and warm desert volcanic rockland. These communities occur along approximately 7.3 percent of the WTS and 2.1 percent of the STS. Along the STS, Colorado Plateau mixed bedrock canyon and tableland is represented.

Developed/disturbed land cover represents approximately 1.0 percent of both the WTS and the STS. Three communities are included within developed/disturbed - agriculture, medium to high intensity development, and low intensity (open space) development.

Semi-desert grassland is approximately 4.0 percent of the land cover types along the STS and includes Apacherian-Chihuahuan semi-desert grassland and steppe. This community is found on gently sloping bajadas that support frequent fire and on mesas and steeper piedmont and foothill slopes in the Chihuahuan Desert. It is characterized by diverse perennial grasses including several grama species (*Bouteloua* spp.), muhly (*Muhlenbergia* spp.), galleta (*Pleuraphis* spp.), and alkaline sacaton. Shrub and tree species also are found, in particular several oak (*Quercus* spp.) and mesquite (*Prosopis* spp.) species.

Mogollon chaparral represents approximately 4.8 percent of land cover along the STS. This community occurs in Arizona at elevations of 4,000 to 6,000 feet amsl (Arizona Game and Fish Department 2006). It typically grows as a dense thicket of evergreen shrubs, dominated manzanita (*Arctostaphylos* spp.), and shrub live oak (*Quercus turbinella*). A number of other shrub species as well as succulents (e.g., prickly pear cactus, agaves, and yuccas) are common. Forbs and grasses are not abundant because of the dense shrub cover.

Madrean conifer woodland represents approximately 7.3 percent of land cover along the STS and includes the vegetative communities of pinyon-juniper woodland, pine-oak forest and woodland, and juniper savanna. Dominate vegetation includes oaks, junipers, and pines. Other common species include oak, alligator bark juniper (*Juniperus deppeana*), one-seed juniper (*Juniperus monosperma*), and pinyon pine.

Upland Sonoran desert scrub is approximately 10.1 percent of land cover along the STS and is represented by Sonoran Paloverde - mixed cacti desert scrub. This community occurs in Arizona from 500 to 3,500 feet amsl (Arizona Game and Fish Department 2006). It has a mix of trees, shrubs, and cacti including blue and yellow palo verde (*Parkinsonia florida*, *P. microphylla*), desert ironwood (*Olneya tesota*), mesquites, catclaw acacia (*Senegalia greggii*), creosote bush (*Larrea tridentata*), brittlebush (*Encelia farinosa*), bursage (*Ambrosia* spp.), saguaro cactus (*Carnegiea gigantea*), and numerous other species.

Chihuahuan desert scrub is approximately 4.9 percent of land cover along the STS. This vegetative community occurs at elevations of 2,000 to 5,500 feet amsl. In the analysis area, this community is an upland shrubland dominated by mesquites and succulents with low grass cover. It typically occurs above the elevation range of creosote bush.

Rocky Mountain forest in the study area is represented by the ponderosa pine woodland community and makes up approximately 1.3 percent of the land cover along the STS. It is dominated by ponderosa pine, with Douglas fir (*Pseudotsuga menziesii*), white fir (*Abies concolor*), and other species also present. It occurs at elevations of 6,000 to 9,000 feet amsl and many stands are relatively open woodlands.

3.8.3.4.2 Riparian/Wetlands

Riparian areas make up 0.5 percent of the land cover located along both transmission lines. Approximately one-third of the riparian habitat along the STS and most of the riparian habitat along the

WTS is dominated by tamarisk. Riparian vegetation along the WTS is present at the crossings of the Colorado River, Kanab Creek, Bitter Seeps Wash, Pipe Valley Wash, Sandridge Wash, Clayhole Wash, Meadow Valley Wash, Virgin River, Beaver Dam Wash, Muddy River, Las Vegas Wash, and some smaller unnamed washes and drainages.

Riparian land cover on the STS includes invasive southwest woodland and shrubland and warm desert woodland and shrubland. Dominate species include cottonwoods, Arizona sycamore (*Platanus wrightii*), Arizona walnut (*Juglans major*), velvet ash (*Fraxinus velutina*), and other species along perennial and intermittent streams. At lower elevations, box elder (*Acer negundo*), velvet ash, Gooding's willow, netleaf hackberry (*Celtis laevigata* var. *reticulata*), and Arizona walnut are common. Invasive southwest riparian woodland and shrubland are present at the crossing of the Little Colorado River. Riparian areas also occur at the crossing of the Verde and Agua Fria rivers.

3.8.3.4.3 Noxious Weeds and Invasive Species

A number of noxious weed and invasive plant species are likely to, or may possibly, occur along the transmission lines (**Table 3.8-2**). Noxious weed species likely to occur along the WTS include field bindweed, halogeton, Russian knapweed, and Scotch thistle. Noxious weeds that are likely to occur along the STS include camelthorn, field bindweed, Russian knapweed, cheatgrass, and red brome.

3.8.4 Environmental Consequences

3.8.4.1 Issues

The following issues related to vegetation resources were identified through public and agency scoping. Although there is overlap, issues vary somewhat by project component.

3.8.4.1.1 Navajo Generating Station

Issue 1 – Operations and Maintenance, including Surface Disturbance - effects of operations and maintenance of NGS and associated facilities, including the BM&LP Railroad.

Issue 2 – Emissions and Deposition - effects of NGS emissions and metals deposition on vegetation and reclamation potential.

3.8.4.1.2 Proposed Kayenta Mine Complex

Issue 1 – Operations and Reclamation - effects of mining operations and reclamation on vegetation resources.

Issue 2 – Emissions and Deposition - effects of combined emissions from the proposed KMC and NGS on vegetation resources.

Issue 3 – Groundwater Pumping - effects of mine-related groundwater pumping from the N-Aquifer on associated stream and spring baseflows that support aquatic, wetland, and/or riparian habitats.

3.8.4.1.3 Transmission Systems and Communication Sites

Issue 1 – Operations and Maintenance - effects of transmission line operations and maintenance on vegetation resources.

3.8.4.2 Assumptions and Impact Methodology

The following is a list of assumptions made and methodology used to assess impacts of the project as they relate to general vegetation. The impacts identified under the separate project components below are based on correspondence with federal and state agencies, tribal representatives, and public scoping comments.

- Non-native and invasive plants are present within the project area.
- Some NGS-associated facilities, including the BM&LP Railroad, and transmission lines have been in place for 40 years and areas have revegetated naturally within the project footprint.
- Impacts associated with decommissioning and reclaiming project facilities including the NGS plant, BM&LP Railroad, and proposed KMC in 2045 are assumed to have only beneficial effects for general vegetation. While there would be temporary disturbance associated with decommissioning activities, the overall effect would be to re-open and restore habitat. Effects of decommissioning are discussed under the No Action Alternative.

3.8.4.2.1 Navajo Generating Station

- Vegetation communities and dominant vegetation cover types for NGS and associated facilities as well as the 20-km deposition area were identified through review of SWReGAP data.
- COPECs in soil were used to identify potential impacts to general vegetation that may be growing within the NGS Near-field ERA study area and HQs were used to identify the potential for risk to plants.
- The results of the NGS Near-field ERA were analyzed to determine deposition impacts to vegetation.
- Vegetation along the BM&LP Railroad was qualitatively evaluated for coal dust deposition. No new surface disturbance is anticipated along the railroad. However, a 250-foot buffer was chosen to account for existing access roads and coal dust deposition from the train.

3.8.4.2.2 Proposed Kayenta Mine Complex

- Vegetative communities were evaluated within mining areas through review of SWReGAP data, previous baseline and field studies of the area, and aerial interpretation of satellite imagery.
- Acres of vegetation communities disturbed by mining were evaluated by overlaying coal lease areas over vegetation communities within a Geographic Information System.
- Within the Kayenta Mine, a 3-Unit Operation and 2-Unit Operation were analyzed to identify surface disturbance impacts.
- Groundwater model results were used to identify where baseflow to springs could be reduced as a result of mine groundwater pumping. The study area defined for surface water and groundwater impacts are referenced from the water resources section and groundwater model.
- No new surface disturbance is anticipated within the N-Aquifer study area outside of the proposed KMC. Only riparian/wetland vegetative communities tied to seeps/springs within this area would have potential to be affected by groundwater drawdown resulting from mine pumping.
- Riparian communities within the N-Aquifer were identified by assessing SWReGAP and LANDFIRE vegetation data, as well as aerial imagery interpretation to more accurately represent riparian areas.

3.8.4.2.3 Transmission Systems and Communication Sites

- General vegetation along the WTS and STS and the communication sites was evaluated qualitatively for Operations and Maintenance (O&M) activities. Substations and switchyards affiliated with the WTS and STS occur in or adjacent to the power line corridor and were included in the analysis.
- The plant communities and dominant vegetation cover types were identified within a 2-mile buffer of the transmission lines.

- Transmission line ROWs and infrastructure have been in place and maintained for 40 years and the proposed vegetation treatments would maintain the existing communities and vegetation types present in the ROWs (i.e., low growing shrub, herbaceous, and grass species).
- The indirect effects of potential introduction and spread of noxious weeds from vehicles or workers, as well as spread from infested areas, are evaluated qualitatively.

3.8.4.3 Proposed Action

3.8.4.3.1 Navajo Generating Station

3.8.4.3.1.1 NGS Operations and Maintenance, including Surface Disturbance

Under the Proposed Action, surface disturbance at the NGS would be approximately 239 acres for the 3-Unit Operation and 199 acres for the 2-Unit Operation. This would result in the direct removal of primarily desert scrub vegetation.

Following grading, where required, and redistribution of topsoil, the areas to be reclaimed would be revegetated with native plants in accordance with lease requirements. It is estimated that herbaceous species (e.g., grasses) would take 2 to 5 years to re-establish and achieve adequate ground cover to prevent erosion and provide forage for wildlife species and grazing operations. Re-establishment of woody shrub species (e.g., sagebrush) would require at least 10 to 25 years. Where soil constraints or presence of noxious and invasive weed species may affect reclamation success, additional measures (e.g., addition of soil amendments, noxious weed controls, etc.) would be implemented. Based on implementation of these measures, it is anticipated that impacts on the vegetation communities around the NGS site and associated facilities would be minor.

Coal delivery under the Proposed Action would be between 5.5 million tons per year (tpy) and 8.1 million tpy. Coal dust generated during coal transport (i.e., along the BM&LP Railroad), handling, and storage could settle on vegetation, potentially resulting in a localized effect to plant health. The potential for untreated or improperly loaded coal to be lost due to wind erosion is greatest during the initial transport near the mine (Winges and Steffel 2016).

Potential impacts from fugitive dust under the Proposed Action would be minimized through the implementation of fugitive dust control measures described in the NGS Operations and Maintenance Plan (**Appendix 1B**). Measures implemented to reduce coal blow-off during transport would include ensuring the coal remains below the top of the train cars during loading and enforcing slow train speeds. To further reduce the generation of coal dust, NGS developed a Dust Control Plan that would continue to be implemented at the plant and associated facilities. In addition, an annual Fugitive Dust Control Report that describes actions taken to control dust, records of citizen complaints, and any corrective measures taken for the Ash Disposal Area also would be generated as required under coal combustion residual regulations (40 Code of Federal Regulations 257.80). Based on implementation of these measures, dust-related effects to vegetation from O&M activities would be negligible.

Under the Proposed Action, the majority of the operating and support facilities at NGS would be dismantled and properly disposed and the area reclaimed at the end of operations, unless the Navajo Nation continues NGS operations beyond 2044. **Appendix 1B** provides an overview of the decommissioning sequence for the plant and associated facilities, including the coal ash landfill and BM&LP Railroad. Under this alternative, approximately 3,724 acres associated with the plant, coal ash landfill, and BML&LP Railroad, would be reclaimed.

3.8.4.3.1.2 Emissions and Deposition

For the NGS ERA terrestrial analysis, potential effects to vegetation were evaluated by comparison of soil concentrations for each COPEC to baseline soil concentrations plus air deposition (to soil) considering both the 3-Unit Operation and 2-Unit Operation. The 3-Unit Operation would result in the highest rate of emission/deposition of COPECs to the environment and represents the maximum amount of deposition to soil within the NGS ERA study area. Based on the result of the NGS ERA, there would be negligible risk to the vegetation community from air emissions alone because maximum HQs for the 3-Unit Operation were determined to be below 1. Also, the contribution of the 3-Unit Operation emissions to overall soil concentrations in the NGS Near-field study area would be less than 6 percent (**Table 3.6-6**).

3.8.4.3.2 Proposed Kayenta Mine Complex

3.8.4.3.2.1 Operations and Reclamation

General Vegetation

Under the Proposed Action, mine pit locations and associated disturbance would be the same for both the 3-Unit Operation and 2-Unit Operation, with the following exceptions. Mining under the 2-Unit Operation would proceed at a slower rate, and no mining would occur in Mining Area N-10. Vegetation clearing, topsoil removal, and mining would continue under this alternative.

Estimated disturbance-related impacts to vegetation within the proposed KMC are provided in **Table 3.8-10**. **Figure 3.8-3** displays the baseline (2019) vegetation communities overlain by coal resource areas to display where impacts to native vegetation would occur. Under this alternative, mine-related surface disturbance at the proposed KMC would be approximately 5,230 acres for the 3-Unit Operation and 4,741 acres for the 2-Unit Operation. The three native vegetative communities that would be affected include pinyon-juniper woodlands, sagebrush shrublands, and mixed salt desert scrub. In addition, Navajo Route 41 would be realigned within the proposed KMC, directly impacting approximately 58 acres of upland vegetation. Forty-six acres of this impact would be within reclaimed areas and 10 acres would be within sagebrush shrublands.

Table 3.8-10 Impacts to Vegetation Communities within the Proposed KMC

Land Cover Type	Acres/Percent of Community Impacted	
	3-Unit Operation (2044)	2-Unit Operation (2044)
Pinyon-juniper Woodlands	4,738 / 20.1	4,306 / 18.3
Sagebrush Shrublands	456 / 3.5	427 / 3.2
Mixed Salt Desert Scrub	35 / 3.6	8 / <1.0
Greasewood Shrubland	0 / 0	0 / 0
Invasive Southwest Riparian Woodland and Shrubland (Tamarisk)	0 / 0	0 / 0
Open Water	0 / 0	0 / 0
Total Acres Impacted	5,230	4,741

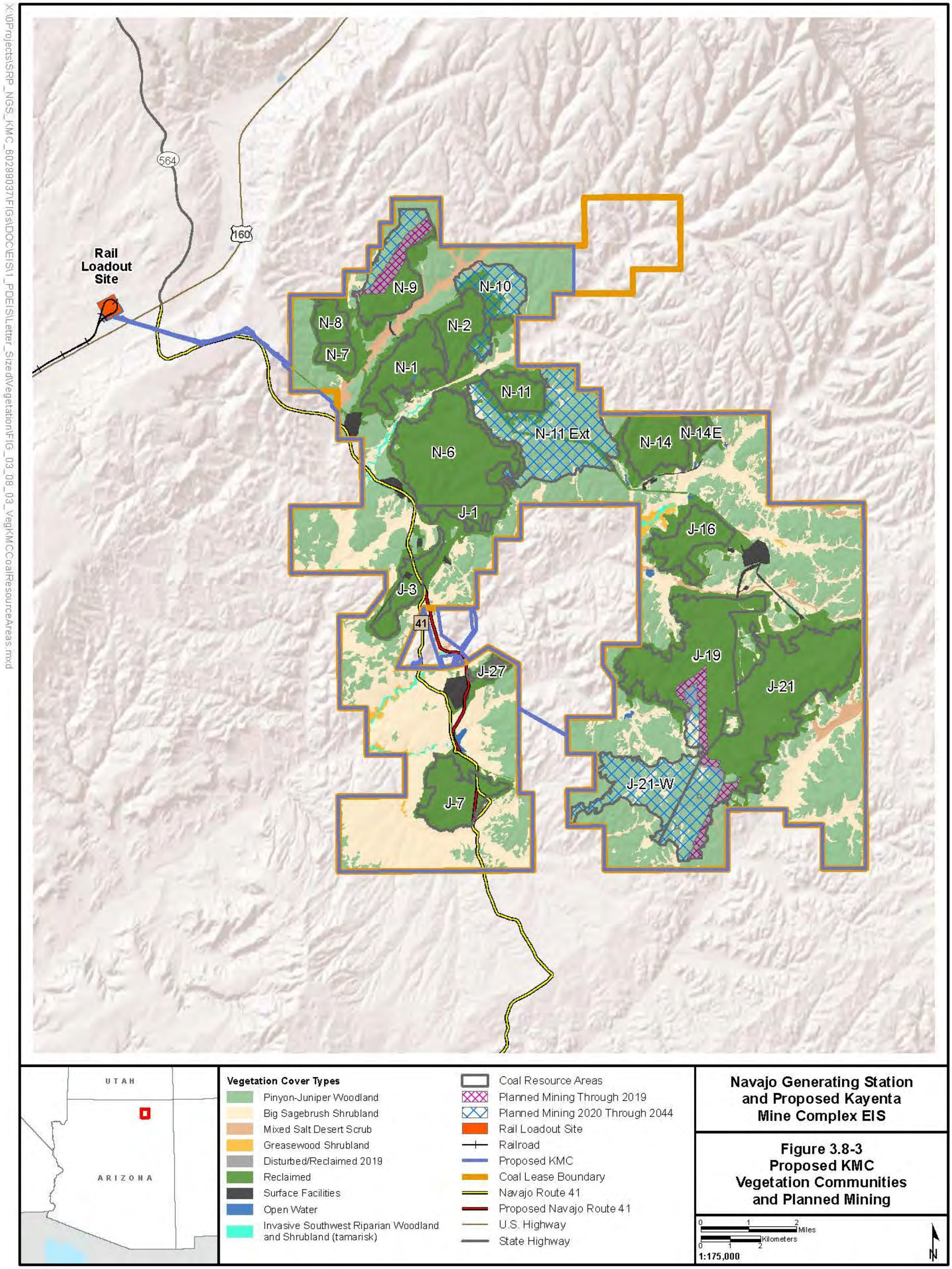

Figure 3.8-3
Proposed KMC Vegetation Communities and Planned Mining

7/20/2016

Reclamation of mine pits would be conducted concurrent with operations. Upon decommissioning, no mining would occur in the proposed KMC after December 22, 2045, and final reclamation would be initiated. Facilities not requested to be kept by the tribes would be removed and recycled or properly disposed. The disturbance areas then would be recontoured to conform to the natural landform, covered with topsoil, and revegetated. Under the Proposed Action, approximately 9,000 to 10,000 acres of mining-related disturbance would be reclaimed.

Removal of pinyon-juniper and shrubland communities would represent a long-term impact (likely 25 to 50 years) until they are restored through mine reclamation efforts and natural re-establishment. It is likely that grassland communities on reclaimed lands would slowly be invaded by shrubs. The persistence of grasslands would depend on the post-reclamation livestock grazing regime and climatic variability over many years. Each of the various reclaimed plant community types has their own regulatory standards for success. For a discussion of reclamation success within the proposed KMC, see Section 3.14.4, Regulatory Framework, Land Use.

The Proposed Action would have moderate effects on the vegetation communities within the proposed KMC study area because approximately 27 percent of the native vegetation within the proposed KMC would be removed through mining operations; however, these areas would be reclaimed as grassland, rangeland, shrubland, or woodland communities. The resulting vegetative communities would increase the livestock carrying capacity and improve the potential for grazing (OSMRE 2011). With the inclusion of the various reclamation vegetative communities and cultural plant sites, long-term effects on plant species diversity are expected to be minor. The post-mining land uses of the reclaimed areas would be similar to pre-mining land uses, including production of forage for grazing, wildlife habitat, and collection of culturally important plants (OSMRE 2008).

Riparian/Wetlands

Small riparian areas are present in the southwest proposed KMC along lower Moenkopi Wash, Red Peak Valley Wash, and Coal Mine Wash. Small areas of wetlands also are present at some ponds. All of these areas are within the leasehold. They may be supported in part by releases from upstream ponds and impoundments and by seepage from those facilities.

Another riparian zone starts about 1.5 miles below the confluence of Coal Mine Wash with Moenkopi Wash and extends downstream for approximately 3 miles. Its greatest width is within the upper 1.5 miles. Downstream of that, a narrower belt of riparian vegetation occurs along the channel. This is the only extensive, downstream riparian area near the leasehold. It occurs in an eroded basin where the Mancos Shale is exposed at the surface. The less permeable nature of the shale forces groundwater to remain near the surface. In combination with inflows and local shale runoff, this groundwater supports the riparian zone downstream until evapotranspiration and channel migration limit the riparian areas expansion.

Under the Proposed Action, effects from reduced average runoff due to impoundments (including temporary sediment ponds and permanent impoundments) could occur at this riparian area but impacts could be too subtle to be detectable. The extent of riparian habitat varies with multi-year precipitation conditions and as Moenkopi Wash migrates within its floodplain and terrace system. These factors would make impacts indistinguishable from ongoing natural processes. Because of these factors, retained storage impacts to riparian areas in or near the leasehold would be negligible. See Section 3.7, Water Resources, for a description of flows and alluvial groundwater that support riparian vegetation downstream of the Kayenta Mine.

Noxious Weeds and Invasive Species

The Proposed Action would disturb between 4,741 and 5,230 acres of native vegetation. Surface disturbance such as those associated with mining have potential to provide pathways for further spread of noxious and invasive species into adjacent undisturbed areas (Gelbard and Belnap 2003; Watkins et al. 2003) and serve as a source of propagules (D'Antonio et al. 2001). Localized surface disturbances could facilitate the invasion of noxious and invasive species by removing native vegetative cover, creating areas of bare ground (Burke and Grime 1996; Watkins et al. 2003), and increasing light and nutrient availability (Stohlgren et al. 2003, 1999). Noxious and invasive weed species would compete with native plants, degrade and modify native communities, and reduce resources for native species (e.g., moisture, soil nutrients, and light). Noxious and invasive weeds also could be spread by vehicles and workers.

In areas of existing noxious weed occurrence, noxious weed control during construction and O&M activities could be difficult due to a local seed source being present. Continuation of best management practices (BMPs) such as monitoring, herbicide use, and other activities listed within the NGS O&M plan would aid in decreasing the spread of these species. The effect of the Proposed Action on noxious weeds is expected to be minor based on continued implementation of BMPs.

3.8.4.3.2.2 Emissions and Deposition

For the KMC ERA emissions analysis, the potential for ecological risk was evaluated by comparison of soil concentrations for each COPEC to baseline soil concentrations plus air deposition (to soil) considering both the 3-Unit Operation and 2-Unit Operation. The resulting HQs were below 1 (Ramboll Environ 2016g) indicating that ecological risk is not likely. Therefore, it is anticipated that there would be negligible risk to the vegetation communities.

3.8.4.3.2.3 Groundwater Pumping

Groundwater modeling was conducted for eight geographical groups of springs to determine if project pumping could affect spring outflows. Details for this analysis are provided in Section 3.7, Water Resources. The model results predict that spring flow reduction from project groundwater pumping could occur in three of the spring groups (in locales near Tuba City, Chinle, and Dennehotso). The model analysis estimated small flow reductions from less than 0.001 to about 0.06 gallons per minute. For most spring groups, simulated changes in hydraulic head (water level at the ground surface) generally ranged from zero to about 0.02 feet. Immediately west of Chinle, the head change ranged up to about 0.1 foot. At the four U.S. Geological Survey-monitored springs, there would be no changes in flow as a result of project pumping under the Proposed Action. Based on the model results, it is expected the changes in water level at the ground surface would have negligible effects to riparian vegetation at seeps/springs.

The modeling study also indicated that the Proposed Action water supply pumping would reduce base flow by less than 1 percent after 2020 in major wash systems that drain across the proposed KMC. Due to past alterations of stream flows in the west, tamarisk has increased in abundance over native species and has been shown to have negative effects on riparian areas (Merritt and Poff 2010; Stromberg et al. 2007). Tamarisk is more drought tolerant than many natives because it is a facultative phreatophyte, meaning that it can use surface water from unsaturated soil as well as groundwater. It also has deep and extensive root systems (Di Tomaso 1998; Zouhar 2003). However, because base flow reduction is anticipated to be less than 1 percent, it is expected the Proposed Action would have negligible effects to riparian communities.

3.8.4.3.3 Transmission Systems and Communication Sites

3.8.4.3.3.1 Operations and Maintenance

Operation and maintenance of the transmission lines and associated facilities require periodic aerial and ground inspections, repair and maintenance of infrastructure, maintenance of access roads, and treatment of vegetation within the ROWs. The majority of all inspection and maintenance activities would occur along the existing ROWs, serviced by existing roads leading to the regional highway system, and would occur infrequently. Because of the infrequent need for vegetation treatments, NV Energy does not have an established periodic routine maintenance program for the WTS. Aerial, ground, and climbing inspections of existing infrastructure is conducted at least once or twice a year for both the WTS and STS as needed. Low-growing species are desired, and vegetation along the ROWs has been treated to support and maintain low-growing species so dense brush does not grow, thereby reducing fire risk. It is anticipate that this type of future vegetation maintenance would continue to occur in previously treated areas and, therefore, would not contribute to vegetation impacts. Other potential effects to vegetation would include erosion and sedimentation caused by maintenance vehicles, fugitive dust generation, and the spread and establishment of noxious or invasive weeds into areas of lower vegetative cover. Because transmission line operators would continue to implement BMPs as described in the NGS Operation and Maintenance Report (**Appendix 1B**), the related effects to vegetation within the WTS and STS corridors would be negligible. The maintenance activities would continue to be coordinated with the land management agencies as required by ROW stipulations.

Riparian and wetland areas constitute a small proportion of the landscapes (less than 2 percent) crossed by the transmission lines. It is anticipated that the Proposed Action would have negligible effects on wetlands/riparian areas based on continued implementation of BMPs described in the NGS Operation and Maintenance Report (**Appendix 1B**).

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

3.8.4.3.4 Project Impact Summary – All Project Components

The total surface disturbance under the Proposed Action would be between 5,527 and 4,998 acres. The overall effects of the Proposed Action on general vegetation would be considered moderate, primarily due to the vegetation removal within the proposed KMC.

Up to 239 acres of vegetation would be removed at the NGS plant and ash disposal site, having a minor impact to general vegetation. Up to 5,230 acres of vegetation would be removed within the proposed KMC, mostly pinyon-juniper woodlands, having a moderate effect on general vegetation. The realignment of Navajo Nation Route 41 will remove 58 acres of vegetation. Effects of O&M activities at NGS and Associated Facilities, the BM&LP Railroad, and the transmission systems would have negligible effects to general vegetation. Potential vegetation impacts related to noxious weed invasion are anticipated to be minor with continued implementation of the current BMPs during O&M activities.

NGS emissions and deposition would represent a negligible risk to general vegetation in the NGS Near-field Study Area, as indicated by HQs that are less than 1. When combining NGS emissions with baseline conditions, there would be a negligible risk to general vegetation based on HQ values less than 1. The KMC ERA indicates emissions from the proposed KMC would pose a negligible risk to general vegetation based on HQ values which are less than 1.

Groundwater pumping in the proposed KMC would result in small baseflow reductions to seeps and springs, representing negligible effects on riparian/wetland vegetation.

3.8.4.3.5 Cumulative Impacts

The vegetation cumulative effects study areas are the same as the direct indirect study areas. Refer to Section 3.0 for a detailed description of these study areas. The cumulative effects analysis includes an assessment of total project effects across all study areas plus the effects of other past and present actions and reasonably foreseeable actions affecting vegetation within these areas.

3.8.4.3.5.1 Operations and Maintenance, including Surface Disturbance

Reasonably foreseeable future actions are anticipated to impact 4,201 acres of vegetation, and past and present actions have impacted approximately 52,786 acres of vegetation. The Proposed Action incrementally would contribute between 4,998 and 5,527 acres of vegetation disturbance to cumulative impacts, resulting in a total cumulative impact to vegetation on between 61,985 and 62,514 acres. It is anticipated that reclamation of portions of past and present actions and reasonably foreseeable future actions have been, or would be, completed in accordance with permit requirements or lease agreements, thereby reducing the cumulative impact to vegetation over time. Reclamation of Proposed Action disturbance areas would minimize the project's contribution to cumulative vegetation impacts.

3.8.4.3.5.2 Emissions and Deposition

Cumulative vegetation impacts resulting from past and present emissions and deposition in the cumulative effects study area are reflected in the NGS Near-field ERA and KCM ERA baseline COPECs analyses. The ERAs also evaluated future ecological risk from ongoing emissions and deposition. Based on the ERA results, the HQs for both baseline and future conditions indicate an ecological risk below 1, indicating that ecological risk to vegetation is not likely under either scenario. Therefore, the project's contribution to cumulative ecological risk for vegetation would be negligible and would cease following completion of operations in 2044.

3.8.4.3.5.3 Proposed KMC Groundwater Pumping

Past and present and reasonably foreseeable future actions that could contribute to drawdown related effects to riparian/wetland vegetation within the N-Aquifer study area include groundwater pumping from community wells for local water use. Groundwater modeling indicates riparian/wetland communities associated with seeps and springs that have hydraulic connection to the N-Aquifer could experience negligible to minor effects as groundwater levels decline from community pumping in future years. The modeling also indicates that the Proposed Action's contribution to groundwater level declines and associated effects to riparian/wetland vegetation at seeps and springs would be negligible.

Figure 3.7-16 illustrates the drawdown cones associated with these community wells, and the proximity of these wells to major regional drainages. Areas of concern include lower Moenkopi Wash near Tuba City and Moenkopi; Pasture Canyon below Shonto and Red Lake; and Laguna Creek near Kayenta. At the Moenkopi Wash and Pasture Canyon locations, projected localized declines in groundwater levels from community groundwater pumping would not intersect with groundwater level changes projected from mine-related pumping as there is only a very small area of intersect (upper Laguna Creek) between the mining and community well pumping cones of depression. Additive cumulative drawdown impacts are anticipated to occur in this area of intersection, along upper Laguna Creek, where a small portion of the overall historic and predicted effects are attributed to mining activity. Based on aerial photo interpretation, site visits, and SWReGAP and LANDFIRE data analysis for Chinle Creek, Laguna Creek, and Polacca Wash, current conditions do not support native riparian vegetation. Therefore, cumulative impacts to riparian vegetation from baseflow changes are expected to be negligible.

3.8.4.4 Natural Gas Partial Federal Replacement Alternative

Under the Natural Gas Partial Federal Replacement (PFR) Alternative, a selected quantity of power between 100 megawatts (MW) and 250 MW would be contracted for under a long-term power purchase agreement from currently unidentified, existing natural gas generation sources, displacing an equivalent amount of power from the federal share of NGS generation. Under this alternative, the natural gas-fired power generating facility is assumed to exist. Therefore, prior disturbance impacts to general vegetation resources at the natural gas-fired facility are not evaluated in this Environmental Impact Statement. Key assumptions about vegetation resources related to such an existing natural gas site are listed below.

- The natural gas plant underwent National Environmental Policy Act evaluation, and state or local permitting.
- A combined-cycle natural gas-fired power plant would typically be located on a site of approximately 100 acres. No additional surface disturbance would be required over time.
- Native vegetation was removed from the site and would not be revegetated until after facility decommissioning.
- Natural gas combustion for power generation would not result in COPEC emissions and deposition that would overlap with the coal combustion emissions and deposition from NGS in the Study Area. The description of emissions calculations for the PFR are described in Chapter 2.0 and in Section 3.1, Air Quality.

3.8.4.4.1 Navajo Generating Station

3.8.4.4.1.1 Operations and Maintenance, including Surface Disturbance

Coal delivery under the Proposed Action would range between 5.5 million tpy and 8.1 million tpy. Under the Natural Gas PFR Alternative, less coal would be handled and transported on the BM&LP Railroad because less power would be generated at NGS. **Table 3.0-6** shows the difference in annual coal production and use. The reductions in coal use would be between 5 and 18 percent annually under the Natural Gas PFR Alternative. Overall, disturbance-related effects to vegetation under this alternative would be similar to the Proposed Action and, therefore, would be minor.

Due to lower coal use at NGS under the Natural Gas PFR Alternative, O&M activities at plant, associated facilities, and the BM&LP Railroad may occur less frequently. With ongoing implementation of fugitive dust control measures, dust-related effects to vegetation from O&M activities would be negligible.

3.8.4.4.1.2 Emissions and Deposition

COPECs, specifically selenium, arsenic, and mercury, associated with the Natural Gas PFR Alternative NGS stack emissions would be reduced relative to the Proposed Action as presented in **Table 3.8-11**.

Table 3.8-11 Emissions Reductions of Selenium, Mercury, and Arsenic Under the Natural Gas PFR Alternative

Trace Metals	Proposed Action Emissions (tpy)		Natural Gas PFR 100-MW Power Reduction (tpy / % change)	Natural Gas PFR 250-MW Power Reduction (tpy / % change)
Selenium	3-Unit	2.237	2.127 / -5%	1.957 / -13%
Selenium	2-Unit	1.491	1.377 / -8%	1.208 / -19%
Mercury (total)	3-Unit	0.117	0.111 / -5%	0.102 / -13%
Mercury (total)	2-Unit	0.078	0.072 / -8%	0.063 / -19%
Arsenic	3-Unit	0.133	0.127 / -5%	0.117 / -13%
Arsenic	2-Unit	0.089	0.083 / -8%	0.073 / -19%

The 3-Unit and 2-Unit 100-MW and 250-MW Natural Gas PFR Alternative operations would result in approximately 5 to 19 percent less selenium, arsenic, and mercury deposition in the NGS Near-field study area than the Proposed Action. However, the emission/deposition-related impacts to general vegetation under the Natural Gas PFR Alternative and the Proposed Action would be similar because the Proposed Action ERA analysis indicates HQ numbers less than 1, indicating negligible risk.

3.8.4.4.2 Proposed Kayenta Mine Complex

3.8.4.4.2.1 Operations and Reclamation

Mining-related surface disturbance at the proposed KMC under the Natural Gas PFR Alternative would be proportionally reduced under this alternative as illustrated in **Table 3.0-7**. It is recognized that actual surface disturbance may not be directly proportional to coal mined because of differences in overburden and coal seam thickness across the coal resource areas. Actual reductions in coal production are displayed in **Table 3.0-6**.

Under the Proposed Action, mining-related disturbance would remove approximately 4,741 to 5,230 acres of native vegetation, resulting in a moderate impact. The disturbance areas would be reclaimed with grassland, rangeland, shrubland, or woodland communities. As displayed in **Table 3.0-7**, the Natural Gas PRF Alternative would result in a reduction in mine-related surface disturbance ranging from 5 to 12 percent for the 3-Unit Operation and from 7 to 18 percent for the 2-Unit Operation. However, similar to the Proposed Action, this would still result in a moderate impact to vegetation. Potential vegetation impacts related to noxious weed invasion are anticipated to be minor with continued implementation of the current BMPs during O&M activities. Overall, impacts to vegetation under this alternative would be similar to those discussed in Section 3.8.4.3.2.

3.8.4.4.2.2 Emissions and Deposition

Under the Natural Gas PFR Alternative, less coal would be produced than under the Proposed Action, resulting in a reduction in mining-related emissions deposition. However, the emission/deposition-related impacts to general vegetation under the Natural Gas PFR Alternative and the Proposed Action would be similar because the Proposed Action ERA analysis indicates HQ numbers less than 1, indicating negligible risk.

3.8.4.4.2.3 Groundwater Pumping

Due to potential drawdown effects from water pumping within the N-Aquifer, groundwater modeling was conducted for eight geographical groups of springs to determine if project pumping could affect spring outflows. Details for this analysis are provided in Section 3.7, Water Resources. Because the same amount of water would be used under the Natural Gas PFR Alternative as under the Proposed Action, groundwater drawdown-related effects to riparian/wetland vegetation at seeps/springs and to riparian vegetation in drainages under this alternative also would be negligible. For more discussion, see Section 3.8.4.3.2.

3.8.4.4.3 Transmission Systems and Communication Sites

3.8.4.4.3.1 Operations and Maintenance

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

O&M activities along the WTS and STS and at communications sites would be the same as the Proposed Action. Because transmission line operators would continue to implement BMPs as described in the **Appendix 1B**, associated impacts to vegetation would be negligible. For more discussion describing impacts to general vegetation through O&M activities within transmission line ROWs, see Section 3.8.4.3.3.

3.8.4.4.4 Project Impact Summary – All Project Components

The total surface disturbance under the Natural Gas PFR Alternative would be between 5,265 and 4,145 acres. The overall effects of the Natural Gas PFR Alternative on vegetation would be considered moderate, primarily due to the vegetation removal within the proposed KMC. Potential vegetation impacts related to noxious weed invasion are anticipated to be minor with continued implementation of the current BMPs during O&M activities.

The Natural Gas PFR Alternative would result in 5 to 19 percent power reduction at NGS compared to the Proposed Action, and reductions in coal production at the proposed KMC would result in an approximate 5 to 18 percent reduction in surface disturbance. These reductions would result in lower emissions and deposition of COPECs within the study area and an anticipated slight reduction in the HQs. Based on the NGS Near-field ERA and KMC ERA evaluations, the HQs under the Proposed Action were determined to be less than 1, indicating a negligible risk to vegetation. The ecological risk to vegetation under the Natural Gas PFR Alternative also would be considered negligible.

Groundwater pumping at the proposed KMC would result in small baseflow reductions to seeps and springs, representing negligible effects on riparian/wetland vegetation.

3.8.4.4.5 Cumulative Impacts

The cumulative vegetation impacts from surface disturbance under the Natural Gas PFR Alterative would be 0 to 1 percent less than those estimated for the Proposed Action. The surface disturbance contributed by the Natural Gas PFR Alternative, past and present actions, and foreseeable future actions is estimated to be between 62,252 to 61,132 acres. Reclamation of Natural Gas PFR Alternative disturbance areas would minimize the project's contribution to cumulative vegetation impacts over time.

Cumulative vegetation impacts resulting from past and present emissions and deposition in the cumulative effects study area are reflected in the NGS Near-field ERA and KCM ERA baseline COPECs analyses. The ERAs also evaluated future ecological risk from ongoing emissions and deposition. Based on the ERA results for the Proposed Action, the HQs for both baseline and future conditions indicate an ecological risk below 1, indicating that ecological risk to vegetation is not likely under either scenario. Although the Natural Gas PFR Alternative would result in a slight reduction in emissions deposition, the project's contribution to cumulative ecological risk for vegetation would be considered negligible and would cease following completion of operations in 2044.

Cumulative impacts to riparian/wetland vegetation as a result of groundwater pumping-related drawdown in the N-Aquifer under the Natural Gas PFR Alternative would be the same as discussed in the Proposed Action cumulative impacts sections. Therefore, cumulative impacts to riparian/wetland vegetation from baseflow changes are expected to be negligible.

3.8.4.5 Renewable Partial Federal Replacement Alternative

Under the Renewable PFR Alternative, a selected quantity of power between 100 MW and 250 MW would be contracted for under a long-term power purchase agreement from a currently unidentified, existing renewable energy power source, displacing an equivalent amount of power from the federal share of NGS generation. Because the renewable energy power facility is assumed to exist, prior disturbance impacts to general vegetation resources from this facility are not evaluated in this Environmental Impact Statement. Key assumptions about vegetation resources related to such an existing site are detailed below.

- A renewable energy power plant would typically be located on a site of approximately 100 acres. No additional surface disturbance would be required over time.
- Vegetation was removed from the site and would not be revegetated until after facility decommissioning.
- The renewable energy operation underwent separate National Environmental Policy Act evaluation.

- Combustion emissions from associated firming power generation would not result in COPEC emissions and deposition that would overlap with the coal combustion emissions and deposition from NGS in the Study Area. The description of emissions calculations for the PFR are described in Chapter 2.0 and in Section 3.1, Air Quality.

3.8.4.5.1 Navajo Generating Station

3.8.4.5.1.1 Operations and Maintenance, including Surface Disturbance

Under the Renewable PFR Alternative, less coal would be handled and transported on the BM&LP Railroad because less power would be generated at NGS. **Table 3.0-6** shows the difference in annual coal production and use. The reductions in coal use would be 2 to 11 percent annually under the Renewable PFR Alternative. Overall, disturbance-related effects to vegetation under this alternative would be similar to the Proposed Action and, therefore, would be minor.

Due to lower coal use at NGS under the Renewable PFR Alternative, O&M activities at plant, associated facilities, and the BM&LP Railroad may occur less frequently. With ongoing implementation of fugitive dust control measures, dust-related effects to vegetation from O&M activities would be negligible.

3.8.4.5.1.2 Emissions and Deposition

COPECs, specifically selenium, arsenic, and mercury associated with the Renewable PFR Alternative NGS stack emissions would be reduced relative to the Proposed Action as presented in **Table 3.8-12**.

Table 3.8-12 Emissions Reductions of Selenium, Mercury, and Arsenic Under the Renewable PFR Alternative

Trace Metals	Proposed Action (tpy)		Renewable PFR 100-MW Power Reduction (tpy / % change)	Renewable PFR 250-MW Power Reduction (tpy / % change)
Selenium	3-Unit	2.237	2.174 / -3%	2.075 / -7%
Selenium	2-Unit	1.491	1.424 / -4%	1.325 / -11%
Mercury (total)	3-Unit	0.117	0.114 / -3%	0.108 / -7%
Mercury (total)	2-Unit	0.078	0.075 / -4%	0.069 / -11%
Arsenic	3-Unit	0.133	0.130 / -3%	0.124 / -7%
Arsenic	2-Unit	0.089	0.086 / -4%	0.080 / -11%

The 3-Unit and 2-Unit 100-MW and 250-MW Renewable PFR Alternative operations would result in approximately 3 to 11 percent less selenium, arsenic, and mercury deposition in the NGS Near-field study area than the Proposed Action. However, the emission/deposition-related impacts to general vegetation under the Renewable PFR Alternative and the Proposed Action would be similar because the Proposed Action ERA analysis indicates HQ numbers less than 1, indicating negligible risk.

3.8.4.5.2 Proposed Kayenta Mine Complex

3.8.4.5.2.1 Operations and Reclamation

Mining-related surface disturbance at the proposed KMC under the Renewable PFR Alternative would be proportionally reduced under this alternative as illustrated in **Table 3.0-7**. It is recognized that actual surface disturbance may not be directly proportional to coal mined because of differences in overburden and coal seam thickness across the coal resource areas. Actual reductions in coal production are displayed in **Table 3.0-6**.

Under the Proposed Action, mining-related disturbance would remove approximately 4,741 to 5,230 acres of native vegetation, resulting in a moderate impact. These areas would eventually be reclaimed with a grassland community. As displayed in **Table 3.0-7**, the Renewable PRF Alternative would result in a reduction in mine-related surface disturbance ranging from 3 to 7 percent for the 3-Unit Operation and from 4 to 10 percent for the 2-Unit Operation. However, similar to the Proposed Action, this would still result in a moderate impact to vegetation. Potential vegetation impacts related to noxious weed invasion are anticipated to be minor with continued implementation of the current BMPs during O&M activities. Overall, impacts to vegetation under this alternative would be the similar to those discussed in Section 3.8.4.3.2.

3.8.4.5.2.2 Emissions and Deposition

Under the Renewable PFR Alternative, less coal would be produced than under the Proposed Action, resulting in a reduction in mining-related emissions deposition. However, the emission/deposition-related impacts to general vegetation under the Renewable PFR Alternative and the Proposed Action would be similar because the Proposed Action ERA analysis indicates HQ numbers less than 1, indicating negligible risk.

3.8.4.5.2.3 Groundwater Pumping

Due to potential drawdown effects from water pumping within the N-Aquifer, groundwater modeling was conducted for eight geographical groups of springs to determine if project pumping could affect spring outflows. Details for this analysis are provided in Section 3.7, Water Resources. Because the same amount of water would be used under the Renewable PFR Alternative as the Proposed Action, effects to riparian/wetland vegetation at seeps/springs and to riparian vegetation in drainages under this alternative also would be negligible.

3.8.4.5.3 Transmission Systems and Communication Sites

3.8.4.5.3.1 Operations and Maintenance

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

O&M activities along the WTS and STS and at communications sites would be the same as the Proposed Action. Because transmission line operators would continue to implement BMPs as described in the **Appendix 1B**, associated impacts to vegetation would be negligible. For more discussion describing impacts to general vegetation through O&M activities within transmission line ROWs, see Section 3.8.4.3.3.

3.8.4.5.4 Project Impact Summary – All Project Components

The total surface disturbance under the Renewable PFR is between 5,369 and 4,524 acres. The overall effects of the Renewable PFR Alternative on vegetation would be considered moderate, primarily due to the vegetation removal within the proposed KMC. Potential vegetation impacts related to noxious weed invasion are anticipated to be minor with continued implementation of the current BMPs during O&M activities.

The Renewable PFR Alternative would result in a 3 to 11 percent power reduction at NGS compared to the Proposed Action, and reductions in coal production at the proposed KMC would result in an approximate 3 to 10 percent reduction in surface disturbance. These reductions would result in lower emissions and deposition of COPECs within the study area and an anticipated slight reduction in the HQs. Based on the NGS Near-field ERA and KMC ERA evaluations, the HQs under the Proposed Action were determined to be less than 1, indicating a negligible risk to vegetation. The ecological risk to vegetation under the Renewable PFR Alternative also would be considered negligible.

Groundwater pumping at the proposed KMC would result in small baseflow reductions to seeps and springs, representing negligible effects on riparian/wetland vegetation.

3.8.4.5.5 Cumulative Impacts

The cumulative vegetation impacts from surface disturbance under the Renewable PFR Alterative would be 0 to 1 percent less than those estimated for the Proposed Action. The surface disturbance contributed by the Renewable PFR Alternative, past and present actions, and foreseeable future actions is estimated to be between 62,356 and 61,511 acres. Reclamation of Natural Gas PFR Alternative disturbance areas would minimize the project's contribution to cumulative vegetation impacts over time.

Cumulative vegetation impacts resulting from past and present emissions and deposition in the cumulative effects study area are reflected in the NGS Near-field ERA and KCM ERA baseline COPECs analyses. The ERAs also evaluated future ecological risk from ongoing emissions and deposition. Based on the ERA results for the Proposed Action, the HQs for both baseline and future conditions indicate an ecological risk below 1, indicating that ecological risk to vegetation is not likely under either scenario. Although the Renewable PFR Alternative would result in a slight reduction in emissions deposition, the project's contribution to cumulative ecological risk for vegetation would be considered negligible and would cease following completion of operations in 2044.

Cumulative impacts to riparian/wetland vegetation as a result of groundwater pumping-related drawdown in the N-Aquifer under the Natural Gas PFR Alternative would be the same as discussed in the Proposed Action cumulative impacts sections. Therefore, cumulative impacts to riparian/wetland vegetation from baseflow changes are expected to be negligible.

3.8.4.6 Tribal Partial Federal Replacement Alternative

Under the Tribal PFR Alternative, between 100 MW and 250 MW of power generation from the NGS would be replaced by power supplied by a new photovoltaic generation facility on tribal land, displacing an equivalent amount of power from the federal share of NGS generation. The construction of a new photovoltaic generation site on tribal land would result in between 1,200 and 3,000 acres of new surface disturbance. The Tribal PFR facility would be analyzed in a separate National Environmental Policy Act process once a facility location is identified. Key assumptions about vegetation resources related to the construction of a new photovoltaic facility are listed below.

- Vegetation would be removed from the entire site and would not be revegetated until after facility decommissioning.
- The emissions caused from construction of the solar facility (fugitive dust and vehicles) could be located in the NGS study area but would be very localized and temporary.
- Combustion emissions from firming power generation would not result in COPEC emissions and deposition that would overlap with the coal combustion emissions and deposition from NGS in the Study Area. The description of emissions calculations for the PFR is described in Chapter 2.0 and in Section 3.1, Air Quality.
- The duration of construction of a photovoltaic site would take between 1.5 and 3 years.

3.8.4.6.1 Navajo Generating Station

3.8.4.6.1.1 Operations and Maintenance, including Surface Disturbance

Under the Tribal PFR Alternative, less coal would be handled and transported on the BM&LP Railroad because less power would be generated. **Table 3.0-6** shows the difference in annual coal production and use. The reductions in coal use would be between 2 and 7 percent annually under the Natural Gas PFR Alternative. Overall, disturbance -related effects to vegetation under this alternative would be similar to the Proposed Action and, therefore, would be minor.

Due to lower coal use at NGS under the Tribal PFR Alternative, O&M activities at plant, associated facilities, and the BM&LP Railroad may occur less frequently. With ongoing implementation of fugitive dust control measures, dust-related effects to vegetation from O&M activities would be negligible.

3.8.4.6.1.2 Emissions and Deposition

COPECs, specifically selenium, arsenic, and mercury, associated with the Tribal PFR Alternative NGS stack emissions would be reduced relative to the Proposed Action as presented in **Table 3.8-13**.

Table 3.8-13 Emissions Reductions of Selenium, Mercury, and Arsenic Under the Tribal PFR Alternative

Trace Metals	Proposed Action (tpy)	Tribal PFR 100-MW Power Reduction (tpy / % change)	Tribal PFR 250-MW Power Reduction (tpy / % change)
Selenium	3-Unit 2.237	2.174 / -3%	2.153 / -4%
Selenium	2-Unit 1.491	1.447 / -3%	1.383 / -8%
Mercury (total)	3-Unit 0.117	0.114 / -3%	0.111 / -5%
Mercury (total)	2-Unit 0.078	0.076 / -3%	0.072 / -8%
Arsenic	3-Unit 0.133	0.130 / -2%	0.128 / -4%
Arsenic	2-Unit 0.089	0.087 / -3%	0.084 / -6%

The 3-Unit and 2-Unit 100-MW and 250-MW Tribal PFR Alternative operations would result in approximately 2 to 8 percent less selenium, arsenic, and mercury deposition in the NGS Near-field study area than the Proposed Action. However, the emission/deposition-related impacts to general vegetation under the Tribal PFR Alternative and the Proposed Action would be similar because the Proposed Action ERA analysis indicates HQ numbers less than 1, indicating negligible risk.

3.8.4.6.2 Proposed Kayenta Mine Complex

3.8.4.6.2.1 Operations and Reclamation

Mining-related surface disturbance at the proposed KMC under the Tribal PFR Alternative would be proportionally reduced as illustrated in **Table 3.0-7**. It is recognized that actual surface disturbance may not be directly proportional to coal mined because of differences in overburden and coal seam thickness across the coal resource areas. Actual reductions in coal production are displayed in **Table 3.0-6**.

Under the Proposed Action, mining-related disturbance would remove approximately 4,741 to 5,230 acres of native vegetation, resulting in a moderate impact. As displayed in **Table 3.0-7**, the Tribal PRF Alternative would result in a reduction in mine-related surface disturbance ranging from 2 to 5 percent for the 3-Unit Operation and from 3 to 7 percent for the 2-Unit Operation. However, similar to the Proposed Action, this would still result in a moderate impact to vegetation. Potential vegetation impacts related to noxious weed invasion are anticipated to be minor with continued implementation of the current BMPs during O&M activities. Overall, impacts to vegetation under this alternative would be similar to those discussed in Section 3.8.4.3.2.

3.8.4.6.2.2 Emissions and Deposition

Under the Tribal PFR Alternative, less coal would be produced than under the Proposed Action, resulting in a reduction in mining-related emissions deposition. However, the emission/deposition-related impacts to general vegetation under the Tribal PFR Alternative and the Proposed Action would be similar because the Proposed Action ERA analysis indicates HQ numbers less than 1, indicating negligible risk.

3.8.4.6.2.3 Groundwater Pumping

Due to potential drawdown effects from water pumping within the N-Aquifer, groundwater modeling was conducted for eight geographical groups of springs to determine if project pumping could affect spring outflows. Details for this analysis are provided in Section 3.7, Water Resources. Because the same amount of water would be used under the Tribal PFR Alternative as under the Proposed Action, groundwater drawdown-related effects to riparian/wetland vegetation at seeps/springs and to riparian vegetation in drainages under this alternative also would be negligible. For more discussion, see Section 3.8.4.3.2.

3.8.4.6.3 Transmission Systems and Communication Sites

3.8.4.6.3.1 Operations and Maintenance

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

O&M activities along the WTS and STS and at communications sites would be the same as the Proposed Action. Because transmission line operators would continue to implement BMPs as described in the **Appendix 1B**, associated impacts to vegetation would be negligible. For more discussion describing impacts to general vegetation through O&M activities within transmission line ROWs, see Section 3.8.4.3.3.

3.8.4.6.4 Project Impact Summary – All Project Components

The total surface disturbance under the Tribal PFR Alternative would be between 5,421 and 4,666 acres. The overall effects of the Tribal PFR Alternative on vegetation would be considered moderate, primarily due to the vegetation removal within the proposed KMC. Potential vegetation impacts related to noxious weed invasion are anticipated to be minor with continued implementation of the current BMPs during O&M activities.

The Tribal PFR Alternative would result in 2 to 8 percent power reduction at NGS compared to the Proposed Action, and reductions in coal production at the proposed KMC would result in an approximate 2 to 7 percent reduction in surface disturbance. These reductions would result in lower emissions and deposition of COPECs within the study area and an anticipated slight reduction in the HQs. Based on the NGS Near-field ERA and KMC ERA evaluations, the HQs under the Proposed Action were determined to be less than 1, indicating a negligible risk to vegetation. The ecological risk to vegetation under the Tribal PFR Alternative also would be considered negligible.

Groundwater pumping in the proposed KMC would result in small baseflow reductions to seeps and springs, representing negligible effects on riparian/wetland vegetation.

3.8.4.6.5 Cumulative Impacts

The cumulative vegetation impacts from surface disturbance under the Tribal PFR Alterative would be 1 to 5 percent higher than those estimated for the Proposed Action. The surface disturbance contributed by the Tribal PFR Alternative, past and present actions, and foreseeable future actions is estimated to be between 65,408 and 62,853 acres. Reclamation of Natural Gas PFR Alternative disturbance areas would minimize the project’s contribution to cumulative vegetation impacts over time.

Cumulative vegetation impacts resulting from past and present emissions and deposition in the cumulative effects study area are reflected in the NGS Near-field ERA and KCM ERA baseline COPECs analyses. The ERAs also evaluated future ecological risk from ongoing emissions and deposition. Based on the ERA results for the Proposed Action, the HQs for both baseline and future conditions indicate an ecological risk below 1, indicating that ecological risk to vegetation is not likely under either scenario.

Although the Tribal PFR Alternative would result in a slight reduction in emissions deposition, the project's contribution to cumulative ecological risk for vegetation would be considered negligible and would cease following completion of operations in 2044.

Cumulative impacts to riparian/wetland vegetation as a result of groundwater pumping-related drawdown in the N-Aquifer under the Natural Gas PFR Alternative would be the same as discussed in the Proposed Action cumulative impacts sections. Therefore, cumulative impacts to riparian/wetland vegetation from baseflow changes are expected to be negligible.

3.8.4.7 No Action

3.8.4.7.1 Navajo Generating Station

NGS and some associated facilities (including the BM&LP Railroad) would be decommissioned and reclaimed after 2019 as described in the NGS Operations and Maintenance Plan (**Appendix 1B**) and Chapter 2.0.

Under the No Action Alternative, activities affiliated with NGS would end 25 years before activities under the Proposed Action, and reclamation would take place sooner. This would result in a decrease in the temporal impacts to vegetation.

Reclamation of the NGS and associated facilities under the No Action Alternative would be the same as under the Proposed Action. Following grading, where required, and redistribution of topsoil, the areas to be reclaimed would be revegetated with native plants in accordance with lease requirements. It is estimated that herbaceous species (e.g., grasses) would take 2 to 5 years to re-establish and achieve adequate ground cover to prevent erosion and provide forage for wildlife species and grazing operations. Re-establishment of woody shrub species (e.g., sagebrush) would require at least 10 to 25 years. Where soil constraints or presence of noxious and invasive weed species may affect reclamation success, additional measures (e.g., addition of soil amendments, noxious weed controls, etc.) would be implemented. Based on implementation of these measures, it is anticipated that impacts on the vegetation communities around the NGS site and associated facilities would be minor.

The cessation of NGS emissions 25 years earlier than under the Proposed Action would reduce the total NGS-related contribution to COPEC deposition in the NGS Near-field ERA study area. However, the emission/deposition-related impacts to general vegetation under the No Action Alternative and the Proposed Action would be similar because the Proposed Action ERA analysis indicates HQ numbers less than 1, indicating negligible risk.

3.8.4.7.2 Proposed Kayenta Mine Complex

Under the No Action Alternative, no mining would occur in the proposed KMC coal resource areas after 2019, thereby reducing the overall acreage of vegetation disturbance as compared to the Proposed Action. Based on SWReGAP data, this reduction would include up to approximately 4,738 acres of pinyon-juniper woodlands, 456 acres of sagebrush shrublands, and 35 acres of mixed salt desert scrub that would not be removed under the No Action Alternative.

Under this alternative, reclamation of disturbance areas, including ancillary facilities and remaining pit areas, would begin in 2019. The reclamation of ancillary areas would be initiated 25 years sooner than under the Proposed Action, resulting in a temporal decrease in vegetation impacts in these areas. However, impacts to vegetation would still be considered moderate due to the scale of affected acreage.

Under the No Action Alternative, groundwater pumping would continue for dust control and assistance with reclamation activities at the rate of approximately 500 acre-feet per year from 2020 through 2022 from the N-Aquifer. Groundwater withdrawals would continue at a rate of approximately 100 acre-feet per year from 2023 through 2032. Although pumping activities under the No Action Alternative would end sooner than under the Proposed Action, the effects to groundwater levels and potential related impacts to riparian/wetland vegetation would be anticipated to be similar to the impacts under the Proposed Action. Therefore, the impacts would be negligible.

3.8.4.7.3 Transmission Systems and Communication Sites

The NGS transmission system is an established part of the western U.S. transmission grid and supports reliability and delivery of power throughout the region, well beyond the power generated by the NGS. Therefore, under the No Action Alternative it is likely that that one, several, or all of the land owners/managers of the transmission line rights-of-way and communication site leases would renew some portion of the facilities to keep the power grid performing as expected.

In the event it is determined that some or all of the transmission systems and communication site ROWs are not renewed, a lengthy study and permitting process would need to occur before any decommissioning is initiated due to the essential and integral nature of these facilities with the western electric grid. As noted in Section 2.3.3, up to 4,826 acres within and alongside the transmission system corridors could be temporarily disturbed if the entirety of the transmission systems and communication sites were decommissioned and removed.

Impacts on vegetation as a result of O&M operations along the WTS and STS and at the communications sites through 2019 would be the same as under the Proposed Action and, therefore, would be negligible.

3.8.4.7.4 No Action Impact Summary – All Project Components

The overall effects of the No Action Alternative on vegetation would be considered moderate, primarily due to vegetation removal at KMC. There would be an overall temporal decrease in vegetation impacts as operations would cease and decommissioning implemented 25 years earlier than under the Proposed Action.

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Section 3.9

Special Status Vegetation Resources

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Acronyms and Abbreviations

1969 Lease	Navajo Project Indenture of Lease
BART	Best Available Retrofit Technology
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BM&LP Railroad	Black Mesa & Lake Powell Railroad
BO	Biological Opinion
CAP	Central Arizona Project
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CO_2	carbon dioxide
COPEC	chemical of potential ecological concern
Co-tenants	Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
Development Fund	Lower Colorado River Basin Development Fund
EIS	Environmental Impact Statement
ERA	Ecological Risk Assessment
ESA	Endangered Species Act of 1973
HHRA	Human Health Risk Assessment
HQ	Hazard quotient
km	kilometer
KMC	Kayenta Mine Complex
kV	kilovolt
kW	kilowatt
MW	megawatt
N-Aquifer	Navajo Aquifer
NEPA	National Environmental Policy Act of 1969, as amended
NGS	Navajo Generating Station
NGS Participants	U.S. (Reclamation), Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
NHPA	National Historic Preservation Act
NNEPA	Navajo Nation Environmental Protection Agency
NO_2	nitrogen dioxide
NO_X	nitrogen oxide
OSMRE	Office of Surface Mining Reclamation and Enforcement
PFR	Partial Federal Replacement
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 microns or less
PWCC	Peabody Western Coal Company
Reclamation	U.S. Bureau of Reclamation

ROW	Right-of-way
SO_2	sulfur dioxide
SRP	Salt River Project Agricultural Improvement and Power District
STS	Southern Transmission System
SWReGAP	Southwest Regional Gap Analysis Project
tpy	tons per year
U.S.	United States
USEPA	U.S. Environmental Protection Agency
WTS	Western Transmission System

Contents

3.9 Special Status Vegetation Resources 3.9-1
3.9.1 Regulatory Framework 3.9-1
3.9.2 Study Areas 3.9-2
3.9.2.1 Proposed Action and Action Alternatives 3.9-2
3.9.2.2 Cumulative 3.9-2
3.9.2.3 Ecological Risk Assessments Role in Assessing Baseline Risk and Environmental Consequences 3.9-3
3.9.3 Affected Environment 3.9-4
3.9.3.1 Navajo Generating Station 3.9-4
3.9.3.2 Proposed Kayenta Mine Complex 3.9-7
3.9.3.3 Transmission Systems and Communication Sites 3.9-9
3.9.4 Environmental Consequences 3.9-14
3.9.4.1 Issues 3.9-14
3.9.4.2 Assumptions and Impact Methodology 3.9-15
3.9.4.3 Proposed Action 3.9-16
3.9.4.4 Natural Gas Partial Federal Replacement Alternative 3.9-21
3.9.4.5 Renewable Partial Federal Replacement Alternative 3.9-24
3.9.4.6 Tribal Partial Federal Replacement Alternative 3.9-26
3.9.4.7 No Action 3.9-29
3.9.5 References 3.9-30

List of Tables

Table 3.9-1 Relevant Statutes, Regulations, and Policies for Plant Species 3.9-1
Table 3.9-2 Special Status Plant Species Occurrence in the NGS Study Areas 3.9-4
Table 3.9-3 Special Status Plant Species Occurrence within the N-Aquifer Study Area 3.9-8
Table 3.9-4 Special Status Plant Species Occurrence along the Transmission Systems 3.9-10
Table 3.9-5 Emissions Reductions of Selenium, Mercury, and Arsenic Under the Natural Gas PFR Alternative 3.9-22
Table 3.9-6 Emissions Reductions of Selenium, Mercury, and Arsenic Under the Renewable PFR Alternative 3.9-25
Table 3.9-7 Emissions Reductions of Selenium, Mercury, and Arsenic Under the Tribal PFR Alternative 3.9-27

3.9 Special Status Vegetation Resources

3.9.1 Regulatory Framework

Laws, regulations, and policies that directly influence vegetation management decisions for the Proposed Action are primarily implemented by the U.S. Fish and Wildlife Service (USFWS), Office of Surface Mining Reclamation and Enforcement, Navajo Nation, Hopi Tribe, Bureau of Indian Affairs, Bureau of Land Management (BLM), U.S. Forest Service (USFS), and National Park Service,. Statutes, regulations and policies relevant to the proposed project are included in **Table 3.9-1**. According to Arizona Statute ARS 3-915, existing electric utility projects are exempt from Arizona native plant law.

Table 3.9-1 Relevant Statutes, Regulations, and Policies for Plant Species

Statutes, Regulations, and Policies	Summary
Surface Mining Control and Reclamation Act of 1977	The Surface Mining Control and Reclamation Act of 1977 establishes a program for the regulation of surface mining activities and the reclamation of coal-mined lands, under the administration of the Office of Surface Mining, Reclamation and Enforcement. The law establishes minimum requirements for all coal surface mining on federal and state lands, including exploration activities and the surface effects of underground mining. Mine operators are required to minimize disturbance and adverse impacts to biological resources and achieve enhancement of these resources where practicable.
Endangered Species Act (ESA) of 1973 (16 USC 1531-1544)	The ESA provides broad protection for species of fish, wildlife, and plants listed as threatened or endangered by the USFWS. Provisions are made for listing species, as well as for recovery plans and the designation of critical habitat for listed species. All federal agencies in consultation with and with the assistance of the USFWS, also must use their authorities in furtherance of the purposes of the ESA by carrying out programs for the conservation of listed species. All federal agencies, in consultation with, and assistance of, the USFWS must ensure any action authorized, funded, or carried out by federal agency is not likely to jeopardize the continued existence of an endangered, threatened, or proposed listed species, or result in destruction or adverse modification of critical habitat of a species. Agencies are required to use the best scientific and commercial data available to fulfill this change.
Navajo Nation Code Title 17, Part 507 [1]	Part 507 of Title 17 of the Navajo Nation Code charges the Resources Committee of the Navajo Nation Council with the development of a list of endangered species and subspecies indigenous to the Navajo Nation and regulates take, possession, transport, export, processing, or sale of any of these species.
BLM Special Status Species Management Policy 6840 (6840 Policy) (Rel. 6-125)	BLM Manual 6840 contains BLM's special status species management policy and guidance for the conservation of special status species and their habitats. Under this policy, special status species include animal and plant species listed as threatened or endangered, proposed for listing, and candidates for listing under the provisions of the ESA; those listed as sensitive species by a state; and those listed by the BLM State Director as sensitive. The objective of this policy is to ensure actions requiring authorization or approval by the BLM are consistent with the conservation needs of special status species and do not contribute to the need to list any special status species, under provisions of the ESA.
USFS Manual 2670	USFS Manual 2670 established objectives for: managing Nation Forest System habitats and activities for threatened and endangered species to achieve recover objectives so that special protection measures provided under the ESA are no longer necessary: promoting species recovery efforts; developing and implementing management practices to ensure that species do not become threatened or endangered because of Forest Service actions; maintaining viable populations of all native and desired nonnative wildlife, fish , and plan species in habitats distributed throughout their geographic range on Nation Forest System lands; and developing and implementing management objectives for populations and /or habitat of sensitive species.

Table 3.9-1 Relevant Statutes, Regulations, and Policies for Plant Species

Statutes, Regulations, and Policies	Summary
National Park Service Management Policy (2006)	Section 4.2.3 “Management of Threatened and Endangered Plants and Animals” of the National Park Service Management Policy (2006) requires the National Park Service to survey for, protect, and strive to recover all species native to the national park system that are listed under the ESA. In addition, the National Park Service is required to inventory, monitor, and manage state and locally listed species in a manner similar to its treatment of federal listed species to the greatest extent possible.

[1] Applies to the Proposed KMC. Pursuant to the Lease Amendment No. 1, or any lease agreement the Nation enters into with the continuing NGS Participants, the Nation does not intend to regulate the NGS lease area.

3.9.2 Study Areas

3.9.2.1 Proposed Action and Action Alternatives

As described in Chapter 1.0, there are three main components of the NGS-KMC Project: the Navajo Generating Station (NGS) and associated facilities, the proposed Kayenta Mine Complex (KMC), and the transmission systems and communication sites. To facilitate description of the affected environment and analysis of Project effects on special status vegetation, a total of six different study areas divided among the three project components have been identified to analyze impacts to special status plants. Refer to Section 3.0 for a detailed description of these study areas. The project components and their associated study areas are listed below:

Navajo Generating Station:

- NGS Near-field study area; and
- Black Mesa & Lake Powell (BM&LP) Railroad study area.

Proposed KMC:

- Proposed KMC study area; and
- Navajo Aquifer (N-Aquifer) study area.

Transmission Systems:

- Western Transmission System (WTS) study area; and
- Southern Transmission System (STS) study area.

As described in Section 3.0, potential water drawdown issues related to mine pumping at the proposed KMC was analyzed through hydrologic modeling. The study area for groundwater effects on special status plants tied to seeps/springs was contained within the N-Aquifer. A detailed discussion of the groundwater study area is provided in Section 3.7.3, Water Resources.

3.9.2.2 Cumulative

For special status plants, the cumulative effects study areas are the same as those described for the Proposed Action and its alternatives. The cumulative effects analysis includes an assessment of total Project affects across all study areas plus the effects of other past and present actions and reasonably foreseeable actions affecting special status plants within these areas. It should be noted that the actions assessed as part of the cumulative effects analysis may be located outside of the study areas listed above (e.g., mercury emissions associated with sources outside of the U.S.). However, to the extent that the effects of these actions combine with Project-related effects to special status plants within the six NGS-KMC study areas listed above, they are assessed as cumulative effects.

3.9.2.3 Ecological Risk Assessments Role in Assessing Baseline Risk and Environmental Consequences

In order to evaluate total future risks associated with future emissions from the NGS, the proposed KMC, and other cumulative sources, it is necessary to consider the level of risk from chemicals of potential ecological concern (COPECs) currently present in the environment (i.e., the environmental baseline). Baseline conditions capture naturally occurring chemicals; past and on-going emissions and deposition from the NGS and proposed KMC; and past and on-going deposition from other local, regional, global sources up to the year 2020. As described in Section 3.0.3, four Ecological Risk Assessments (ERAs) were performed to evaluate environmental conditions in the vicinity of the NGS and proposed KMC. The NGS Near-field ERA evaluated the potential risk to special status vegetation species based on concentrations of NGS emission chemicals in soil within a 20-kilometer (km) radius deposition area around the NGS plant. The proposed KMC ERA evaluated potential risk to special status vegetation resulting from baseline conditions, proposed future mine operations, NGS emissions, and other cumulative sources of COPECs within the proposed KMC. The Gap Regions and San Juan River ERAs evaluated potential risks associated with baseline conditions as well as future operations of NGS to aquatic species along the Colorado and San Juan Rivers outside of the NGS Near-field study area. No special status aquatic plant species live within these areas, so the NGS Near-field and proposed KMC ERAs were used to analyze special status vegetation. The determination of the ERA study areas is discussed in Section 3.0.2 and described in detail in **Appendix 3RA**, Ecological and Human Health Risk Assessments. Ecological risk for special status vegetation species that only have potential to occur along the transmission systems is not evaluated. It is assumed that, outside of the NGS Near-field study area, species occurring along the WTS and STS corridors would not be affected by NGS emissions.

The exposure pathway evaluated for terrestrial special status vegetation included direct contact with COPECs in surface soil. Special status plant tissue samples were not collected or considered for the analysis. Data used to characterize baseline conditions for the ERA study areas around the NGS was obtained from a combination of literature reviews, available data, and field sampling.

Hazard quotients (HQs) are calculated for each COPEC for each species considered. HQs are a unitless ratio of known or predicted COPEC concentrations and the appropriate ecological screening value below which impacts to a given species from exposure to a given constituent are unlikely. The HQ is not a predictor of risk but rather is an indicator of whether or not there is a potential for risk. More information on how HQs are calculated and what the HQ result means is provided in Section 3.0.3 and in **Appendix 3RA**, Ecological and Human Health Risk Assessments. The HQ valued calculated for exposure to maximum concentrations of COPECs, denoted herein as HQ_{max}, is considered a screening-level HQ. It provides a very conservative indicator of risk because receptors would practically never be exposed to maximum concentrations of COPECs in the wild. The HQ value calculated for refined concentrations of COPECs, denoted herein as $HQ_{refined}$, is considered to be a more realistic indicator of ecological risk than HQ_{max}.

If the maximum value of HQ_{max} at the no adverse effects level across all COPECs is less than 1 or equal to (≤) 1, risk to the species is considered unlikely and negligible. If HQ_{max} is greater than (>) 1, ecological risk is evaluated further using $HQ_{refined}$ for the particular chemical of concern. If $HQ_{refined}$ is less than (<) 1, risk is considered negligible. Conversely, if $HQ_{refined}$ is greater than or equal to (≥) 1 there is a potential risk to that species from one or more COPECs (**Appendix 3RA**, Ecological and Human Health Risk Assessments). Risks to special status vegetation associated with baseline conditions are discussed in the Affected Environment section. Risks associated with the Proposed Action, and the Proposed Action when added to baseline conditions, are disclosed in the Environmental Consequence section. It should be noted that all HQs presented for the Proposed Action are associated with the 3-Unit Operation and are considered a worst-case scenario. HQs for the 2-Unit Operation are slightly lower than those for the 3-Unit Operation but, given that ecological risk to special status vegetation is primarily a factor of baseline conditions and, in one case, other cumulative sources, implementation of the 2-Unit Operation would provide only incremental benefits to special status vegetation relative to the 3-Unit Operation.

3.9.3 Affected Environment

The lists of special status plant species from the USFWS, Navajo Natural Heritage Program, USFS (Kaibab and Prescott National Forest), and BLM Arizona (Arizona Strip Field Office), Utah (Grand Staircase-Escalante National Monument, St. George Field Office), and Nevada were combined to create a consolidated list of species. The study areas were evaluated for each plant species based on known distribution and potential habitat. Consultation was held with the individual agencies to assist in the selection of the special status plant species to be carried forward for detailed study.

3.9.3.1 Navajo Generating Station

Two federally listed species have known occurrences within the NGS Near-field study area: Brady pincushion cactus (*Pediocactus bradyi*) and Welsh's milkweed (*Asclepias welshii*). Based on distribution and habitat, one other federally listed species, Fickeisen plains cactus (*Pediocactus peeblesianus* var. *fickeiseniae*), has the potential to occur in the NGS Near-field study area (i.e., 20-km-radius) deposition area. **Table 3.9-2** provides a list of all special status plant species with known occurrence or potential habitat in the NGS study areas. Information on life history, habitat association, conservation status, and recovery for federally listed species is provided in the following sections.

Table 3.9-2 Special Status Plant Species Occurrence in the NGS Study Areas

Species	Status[1]	NGS Area[2]	BM&LP Railroad
Federally Listed Special Status Plant Species			
Brady pincushion cactus (*Pediocactus bradyi*)	FE, NESL G2	K	--
Fickeisen plains cactus (*Pediocactus peeblesianus* var. *fickeiseniae*)	FE, FS, NESL G3	P	--
Welsh's milkweed (*Asclepias welshii*)	FT, NESL G3	K	P
Other Special Status Plant Species			
Alcove death camas (*Zigadenus vaginatus*)	NESL G3	P	--
Kaibab plains cactus (*Pediocactus paradinei*)	FS; BLMS (CCA)	P	P
Marble Canyon milk-vetch (*Astragalus cremnophylax* var. *hevronii*)	FS; BLMS	P	--
Mojave indigo bush (*Psorothamnus arborescens* var. *pubescens*)	BLMS	K	K

[1] Status: FE = Federal Endangered, FT = Federal Threatened, NESL = Navajo Endangered List, G2 = Group 2, G3 = Group 3, FS = Forest Sensitive, BLMS = BLM Sensitive, CCA = Candidate Conservation Agreement.

[2] Occurrence Categories: K = Known occurrence based on Natural Heritage Program data, Navajo data, and agency input; P = Potential occurrence based on distribution and habitat information, agency input, the USFWS IPaC system; SW = occurs in the Southwest Gap Region only.

Potential habitat exists within the BM&LP Railroad 250-foot analysis buffer for Welsh's milkweed among several stabilized dune habitats (Mikesic and Roth 2008).

3.9.3.1.1 Brady Pincushion Cactus

3.9.3.1.1.1 Species Occurrence

Brady pincushion cactus is found on plateaus beside the Colorado River, including both rims of Marble Canyon, which lies approximately 12 to 48 miles southwest of NGS (Navajo Nation Department of Fish and Wildlife 2014). Potential habitat does exist in the NGS Near-field study area.

3.9.3.1.1.2 Life History and Habitat Association

Brady pincushion cactus grows sporadically within sparsely vegetated desert scrub communities dominated by shadscale, snakeweed, Mormon tea, and desert trumpet (*Eriogonum inflatum*). It occurs as sporadic, dense populations along sloped benches in sunny locations (USFWS 2012) and is restricted to habitat composed of Kaibab limestone chips over soil derived from sandstone outcrops and Moenkopi shale. The species occurs between 3,861 to 4,488 feet above mean sea level (amsl) and flowers between March and April (USFWS 2012).

3.9.3.1.1.3 Listing and Conservation Status

Brady pincushion cactus is a small succulent listed as endangered pursuant to the ESA in October 1979. Current threats to this species include invasive species, collection, off-road vehicle use, mining, and livestock grazing (USFWS 2012). Because there are known occurrences of this species within the NGS Near-field study area, past activities related to NGS construction and surface disturbance may have impacted this species, but there is no available information concerning population numbers prior to activities related to NGS. On the Navajo Nation, it is hypothesized that there were more thriving populations, but human foot and vehicle traffic may have killed many of these cacti (Hazelton 2014). No critical habitat has been designated for Brady pincushion cactus. A recovery plan was completed in 1985 and a 5-year status review was completed in 2012. It was recommended that the species classification remain endangered and the recovery priority number be changed from a 2 (high degree of threat and high recovery potential) to a 5 (high degree of threat and low recovery potential) (USFWS 2012). This is based on evidence the cactus is long-lived and exhibits low fecundity. The only criterion for down-listing contained within the recovery plan is permanent protection of at least 75 percent of the known habitat. Other criteria could not be evaluated due to inadequate information on its population numbers (USFWS 2012).

3.9.3.1.1.4 Factors Affected Species

The NGS Near-field study area includes an evaluation of representative plant species expected to occur in the area. Risk calculations were not performed for all special status plants because of the similarity of habitat and exposure patterns among closely related species. Representative species were selected based on multiple discussions with stakeholders and the USFWS. Brady pincushion cactus was one of the special status plants selected as a representative species within the NGS Near-field study area ERA analysis. Field sampling of soil conditions was conducted in 2014 near known locations of the cactus to assess baseline risk from COPECs. HQs for all COPECs using maximum soil concentrations were below 1. Because HQs were below 1 using maximum concentrations, baseline soil conditions are negligible and unlikely to pose a risk to Brady pincushion cactus.

3.9.3.1.2 Fickeisen Plains Cactus

3.9.3.1.2.1 Species Occurrence

Potential habitat for Fickeisen plains cactus exists within the NGS Near-field study area. Habitat for this species includes shrubland and desert scrub communities, but is restricted to specific soils and geological substrates. It is known to occur in Coconino and Mohave counties in Arizona. In Coconino County, they are scattered from House Rock Valley and Gray Mountain, as well as the canyons of the Little Colorado and Colorado rivers. Populations in Mohave County have been found as far west as Dutchman Draw and Grandstand (Mikesic and Roth 2008).

3.9.3.1.2.2 Life History and Habitat Association

Fickeisen plains cactus is a narrow endemic restricted to exposed layers of Kaibab limestone within the Colorado Plateau. They are found in well-drained, shallow, gravelly loam soils formed from alluvium, colluvium, or Aeolian deposits derived from limestone of the Harrisburg Member of the Kaibab and Toroweap Formations. Most populations occur on the margins of canyon rims, flat terraces and benches, or toes of well-drained hills having less than 20 percent slope within the plains and Great Basin grasslands and desert scrub communities. Populations are widely scattered and found at approximately 4,200 and 5,959 feet amsl (USFWS 2015g). The species flowers in late April and produces fruit from May to June (Mikesic and Roth 2008).

3.9.3.1.2.3 Listing and Conservation Status

Fickeisen plains cactus was listed as endangered pursuant to the ESA in October 2013. It also is a Navajo endangered and USFS-listed sensitive plant. Because there are known occurrences within the NGS Near-field study area, past activities related to NGS construction and surface disturbance may have impacted this species, but there is no available information concerning population numbers prior to activities related to NGS. Past and current threats to this small succulent include habitat destruction, modification, and degradation from livestock grazing, predation by small mammals, natural environmental variability, and effects of climate such as drought. Small population size likely exacerbates the effects of these threats (USFWS 2013a). In 2013, the USFWS reopened the comment period concerning the proposed critical habitat for this species (USFWS 2013a). The proposed critical habitat for this species is discussed more thoroughly under the WTS and STS sections of this chapter. No recovery information is available for the Fickeisen plains cactus (USFWS 2015g).

3.9.3.1.2.4 Factors Affecting Species

Fickeisen plains cactus has not been confirmed within the NGS Near-field study area, but was chosen as a representative plant species for analysis. HQs for all COPECs using maximum soil concentrations were below 1. Because HQs were below 1 using maximum concentrations, baseline soil conditions are negligible and unlikely to pose a risk to Fickeisen plains cactus.

3.9.3.1.3 Welsh's Milkweed

3.9.3.1.3.1 Species Occurrence

Known occurrences of Welsh's milkweed exist within the NGS Near-field study area within a BLM Wilderness Area. Potential habitat occurs along the BM&LP Railroad among stabilized sand dune communities (Navajo Nation Department of Fish And Wildlife 2014). Known occurrences occur within the WTS and potential habitat along the STS.

3.9.3.1.3.2 Life History and Habitat Association

Welsh's milkweed grows on open, sparsely vegetated, semi-stabilized sand dunes and the lee slopes of actively drifting sand dunes (USFWS 2015e). These active sand dunes are found within sagebrush, juniper, and ponderosa pine communities and occur from 4,700 to 6,200 feet amsl (USFWS 2015h). Flowering occurs from June to July (Mikesic and Roth 2008).

There are eight known populations of Welsh's milkweed (USFWS 2015h). They occur in the Coral Pink Sand Dunes and the Sand Hills, both in Kane County, Utah, as well as in northern Arizona (Mikesic and Roth 2008; USFWS 2015e,h). On the Navajo Nation, Welsh's milkweed occurs near Tuba City and Comb Ridge. Potential habitat also exists on tribal land on active sand dunes between Page and Tuba City, east to the Chinle Creek drainage (Mikesic and Roth 2008). At the time of listing, the population was estimated to be 11,000 individuals, now considered stems, many of which can be connected underground as part of one individual plant. Currently, there are an estimated 72,000 stems distributed over 8,000 acres among the eight populations, with 98 percent of the stems in Coral Pink Sand Dunes, which is jointly managed by the BLM and the State of Utah (USFWS 2015h).

3.9.3.1.3.3 Listing and Conservation Status

Welsh's milkweed is an herbaceous perennial forb listed as threatened in October 1987. It also is a Navajo Endangered G3 species. Primary threats to the species include off-highway vehicle use and oil and gas development, with cattle grazing named as a potential threat (USFWS 1987b). Past activities, especially, off-highway vehicle use, may have impacted this species, but there is no available information concerning population numbers prior to activities related to NGS. Critical habitat has been designated for this species on BLM lands within the Sand Hills and Coral Pink Sand Dunes, approximately 65 to 75 miles west-northwest of NGS. A recovery plan was completed in 1992 (USFWS 1992). In 2011, Welsh's milkweed was recommended for a 5-year review with 11 other Mountain-Prairie Region species to revisit listing status (USFWS 2011). The results of this review were published in 2015 with a recommendation to revise the recovery plan due to insufficient measureable recovery criteria (USFWS 2015h).

3.9.3.1.3.4 Factors Affecting Species

Welsh's milkweed was chosen as a representative plant species for NGS Near-field study area ERA analysis. HQs for all COPECs using maximum soil concentrations were below 1 for representative plants. Because HQs were below 1 using maximum concentrations, baseline soil conditions are negligible and unlikely to pose a risk to Welsh's milkweed.

3.9.3.2 Proposed Kayenta Mine Complex

No known occurrences or potential habitat exists within the proposed KMC for any special status species, including federally listed species. Potential habitat does exist within the N-Aquifer study area for the federally listed Navajo sedge, which is adapted to the hanging garden communities in seeps and springs and was analyzed for impacts due to water drawdown from pumping for the mine. Alcove bog orchid and alcove death camas, NESL G3 species, also have potential habitat in the N-Aquifer among seeps/springs. Life history, habitat association, conservation status, and recovery information for Navajo sedge is presented below. Other special status plant species known to occur or to have the potential to occur within the N-Aquifer study area potentially affected by mining activities are listed in **Table 3.9-3**.

3.9.3.2.1 Navajo Sedge

3.9.3.2.1.1 Species Occurrence

No known occurrences or potential habitat exist for Navajo sedge within the proposed KMC (Peabody Western Coal Company [PWCC] 2012 et seq.), but there are known occurrences within the N-Aquifer study area. The range of Navajo sedge on the Navajo Nation is from the Lukachukai Mountains, south to Canyon de Chelly and north to the San Juan River. The N-Aquifer study area falls within the range of this species.

3.9.3.2.1.2 Life History and Habitat Association

Navajo sedge is a wetland obligate of seeps/springs and typically is found in hanging gardens within alcoves of sandstone cliffs of varying height and slope between 4,200 and 7,600 feet amsl (USFWS 2014). Hanging gardens occur on nearly inaccessible cliff faces to accessible alcoves. It is associated with other hanging garden plants such as Eastwood's monkey flower (*Mimulus eastwoodiae*), giant helleborine (*Epipactis gigantae*), sand bluestem (*Andropogon hallii*), thistles (*Cirsium* sp.), foxtail barley (*Hordeum jubatum*), and common reed (*Phragmites communis*) (USFWS 2015d). Navajo sedge flowers between late June and September (USFWS 2014).

Table 3.9-3 Special Status Plant Species Occurrence within the N-Aquifer Study Area

Species	Status[1]	N-Aquifer Study Area[2]
Federally Listed Special Status Plant Species		
Navajo sedge (*Carex specuicola*)	FT, NESL G3	K (CH)
Other Special Status Plant Species		
Alcove Bog-orchid (*Platanthera zothecina*)	NESL G3	P
Alcove Death Camas (*Zigadenus vaginatus*)	NESL G3	P

[1] Status: FE = Federal Endangered, FT = Federal Threatened, NESL = Navajo Endangered Species List, G3 = Group 3, FS = Forest Service Sensitive, BLMS = BLM Sensitive.

[2] Occurrence Categories: K = Known occurrence based on Natural Heritage Program data, Navajo Nation data, and agency input; P = Potential occurrence based on distribution and habitat information, agency input, and the USFWS IPaC system; (CH) = Critical Habitat.

At the time of federal listing, Navajo sedge was only known from three springs, all within a 1-mile stretch along a trail within the Navajo Nation in Coconino County, Arizona. These three sites are now considered one population by the Navajo Natural Heritage Program. At this writing, there are 57 known populations across the range of this species managed by the Navajo Nation, Hopi Tribe, National Park Service, and BLM. This increase in number most likely is based on increased survey effort rather than an increase in abundance. Based on geologic characteristics, the species has the potential to extend farther north and west into Utah (USFWS 2014).

The proposed KMC is located on the Wepo Aquifer with the N-Aquifer underlain approximately 2,000 feet below. It appears that Navajo sedge is supported by seeps/springs on the edge of the N-Aquifer rather than the Wepo Aquifer. This assertion is supported by vegetation surveys within the proposed KMC that were conducted in 2003. These surveys were focused on the J28 and N10 coal lease areas and no Navajo sedge occurrences or potential habitat was located during the survey (ESCO and PWCC 2003).

3.9.3.2.1.3 Listing and Conservation Status

Navajo sedge is a perennial forb listed as threatened pursuant to the ESA in May 1985. It also is a Navajo Endangered G3 species. Threats to this species include livestock trampling, habitat loss from groundwater development, and climate change. It is likely that livestock trampling and habitat loss from cattle grazing has affected this species prior to NGS development, but there is no available information concerning population numbers prior to activities related to NGS. The Navajo Nation has now been monitoring this species for 30 years (Roth 2004). It was found that 80 percent of the hanging gardens visited was accessible to livestock, some heavily impacted by trampling (Roth 2004). For projects that may affect groundwater development, evaluation is recommended by the USFWS (USFWS 2014). It is not possible to predict at this time how the local climate may change to the extent that it would affect Navajo sedge habitat. Weather events are likely to become more extreme with periods of drought and flood, which could affect seeps and springs.

Critical habitat has been designated for this species and is located approximately 20 miles northwest of the proposed KMC. A recovery plan was completed in 1987, and at the time of publication, no criteria for delisting had been established. Studies implemented due to the recovery plan were to provide the necessary data from which quantifiable delisting criteria could be established (USFWS 1987a). In 2014, Navajo sedge underwent its latest 5-year review by the USFWS to revisit its listing status. The results of this review deemed that no change is necessary for the status of the species and that it should remain threatened (USFWS 2014). As of this last review, delisting criteria still had not been established, although it does identify recovery actions intended to protect the sedge while information is collected to create criteria.

3.9.3.2.1.4 Factors Affecting Species

The Proposed Action groundwater model analysis takes into account historical effects (baseline) through the end of 2019. For more information, see Section 3.7.4.2, under *Proposed Kayenta Mine Complex* and historical mine withdrawals are provided in **Appendix WR-7, Table WR-7.1**. Maximum N-Aquifer withdrawals for the mine were 4,740 acre-feet per year in 1982. More recently, in 1982, N-Aquifer water use at the mine was 4,480 acre-feet per year. The mean annual pumping for 2006 through 2012 was about 1,273 acre-feet per year. It is unknown how these past withdrawals affected the seep and spring habitats of Navajo sedge.

Due to known locations of Navajo sedge around the proposed KMC, it was evaluated as a special status plant within the proposed KMC ERA analysis. Results showed baseline soil conditions are negligible and unlikely to pose a risk to Navajo sedge based on HQ_{max} <1.

3.9.3.3 Transmission Systems and Communication Sites

The WTS extends west from NGS to the Mojave Desert and Great Basin in southern Nevada. The eastern portions of the WTS cross vegetation typical of the Colorado Plateau including Great Basin conifer woodland and Great Basin desert scrub. The western portion crosses Mojave Desert scrub, with nearly half of the transmission line crossing desert scrub habitat (U.S. Geological Survey 2004).

The STS extends south from the cold deserts of the Colorado Plateau to the northern part of the Sonoran Desert north of Phoenix, Arizona. Major biotic communities include Great Basin conifer woodland, Great Basin desert scrub, Plains and Great Basin grasslands, and upland Sonoran desert scrub.

As listed in **Table 3.9-4**, potential habitat exists within the WTS 2-mile corridor and communication sites analysis area for the following federally listed species: Brady pincushion cactus, dwarf bear-poppy, and Jones cycladenia. Siler pincushion cactus, Fickeisen plains cactus (proposed critical habitat), Holmgren milkvetch (critical habitat), Gierisch mallow, and Welsh's milkweed have known occurrences along the WTS. Fickeisen plains cactus also has proposed critical habitat along the STS with known occurrences. Potential habitat for Welsh's milkweed occurs along the STS. Life history, habitat association, conservation status, and recovery information for dwarf bear-poppy, Gierisch mallow, Holmgren milkvetch, Jones cycladenia, and Siler pincushion cactus is presented in the sections that follow. For information on the other federally listed species, see Section 3.9.2.2, NGS and Associated Facilities and Section 3.9.2.3, Proposed KMC. Other special status plant species with potential to occur along the transmission lines and communication sites that may be affected by maintenance operations are listed in **Table 3.9-4**.

Table 3.9-4 Special Status Plant Species Occurrence along the Transmission Systems

Species	Status[1]	Transmission System[2]	
		WTS	STS
Federally Listed Special Status Plant Species			
Brady pincushion cactus (*Pediocactus bradyi*)	FE, NESL G2	P	U
Dwarf bear-poppy (*Arctomecon humilis*)	FE	P	U
Fickeisen plains cactus (*Pediocactus peeblesianus* var. *fickeiseniae*)	FE, FS, NESL G3	K (PCH)	K (CH)
Gierisch mallow (*Sphaeralcea gierischii*)	FE	K (CH)	U
Holmgren milk-vetch (*Astragalus holmgreniorum*)	FE	K (CH)	U
Jones cycladenia (*Cycladenia humilis* var. *jonesii*)	FT	P	U
Siler pincushion cactus (*Pediocactus sileri*)	FT, BLMS	K	U
Welsh's milkweed (*Asclepias welshii*)	FT, NESL G3	K	P
Other Special Status Plant Species			
Arizona Bugbane (*Cimicifuga arizonica*)	CAS	--	P
Atwood's pretty phacelia (*Phacelia pulchella* var. *atwoodii*)	BLMS	P	U
Baird camissonia (*Camissonia bairdii*)	BLMS	P	U
Barneby breadroot (*Pediomelum aromaticum* var. *barnebyi*)	BLMS	P	U
Beaver Dam Milk-vetch (*Astragalus geyeri* var. *triquetrus*)	BLMS	K	U
Chinle chia (*Salvia columbariae* var. *argillacea*)	BLMS	P	U
Chinle evening primrose (*Oenothera murdockii*)	BLMS	P	U
Cronquist's phacelia (*Phacelia cronquistiana*)	BLMS	P	U
Cutler lupine (*Lupinus caudatus* var. *cutleri*)	BLMS	P	U
Escarpment milkvetch (*Astragalus striatiflorus*)	BLMS	P	U
Gooseberryleaf globemallow (*Sphaeralcea grossulariifolia* var. *fumariensis*)	BLMS	P	U
Gould camissonia (*Camissonia gouldii*)	BLMS	P	U
Gumbo milkvetch (*Astragalus ampullarius*)	BLMS	P	U

Table 3.9-4 Special Status Plant Species Occurrence along the Transmission Systems

Species	Status[1]	Transmission System[2]	
		WTS	STS
Kaibab Plains Cactus (*Pediocactus paradinei*)	CAS, FS, BLMS	P	U
Kanab thelypody (*Thelypodiopsis ambigua* var. *erecta*)	BLMS	P	U
Kane breadroot (*Pediomelum megalanthum* var. *epipsilum*)	BLMS	P	U
Las Vegas Buckwheat (*Eriogonum corymbosum* var. *nilesil*)	BLMS	K	U
Nevada willowherb (*Epilobium nevadense*)	BLMS	P	U
Parry's petalonyx (*Petalonyx parryi*)	BLMS	P	U
Silverleaf sunray (*Enceliopsis argophylla*)	BLMS	P	U
Sticky wild buckwheat (*Eriogonum viscidulum*)	BLMS	K	U
Utah spurge (*Euphorbia nephradenia*)	BLMS	P	U
Whitetip clover (*Trifolium variegatum* var. *parunuweapensis*)	BLMS	P	U
Wirestem buckwheat (*Eriogonum pharnaceoides* var. *cervinum*)	BLMS	P	U

[1] Status: FE = Federal Endangered, FT = Federal Threatened, NESL = Navajo Endangered Species List, G2 = Group 2, G3 = Group 3, FS = Forest Service Sensitive, BLMS = BLM Sensitive, CAS = Conservation Agreement Species.

[2] Occurrence Categories: K = Known occurrence based on Natural Heritage Program data, Navajo Nation data, and agency input; P = Potential occurrence based on distribution and habitat information, agency input, and the USFWS IPaC system; CH = Critical Habitat; U = occurrence unknown.

3.9.3.3.1 Dwarf Bear-poppy

3.9.3.3.1.1 Species Occurrence

Potential habitat for dwarf bear-poppy exists along the WTS, restricted to the southwestern corner of Utah near St. George in Washington County (Tilley et al. 2010; USFWS 2015a). This species inhabits desert shrub communities, but is restricted to specific substrates.

3.9.3.3.1.2 Life History and Habitat Association

Dwarf bear-poppy is endemic to specific substrates derived from the Moenkopi Formation with soils slightly basic and high in gypsum and calcium carbonate (USFWS 2015a). There are approximately 12 populations within 10 miles of St. George, with the largest near Red Bluff, Webb Hill, White Dome, Punchbowl Dome and Atkinville (Tilley et al. 2010).

Dwarf bear-poppy grows within mixed desert shrub communities between 2,500 and 3,400 feet amsl dominated by Fremont indigo bush (*Psorothamnus fremontii*), cheesebush (*Hymenoclea salsola*), Mormon tea, shadscale, shrubby buckwheat (*Eriogonum corymbosum*), and Fremont pepperweed

(*Lepidium fremontii*). The species flowers in April and May with peak flowering occurring in early May (USFWS 2015a).

3.9.3.3.1.3 Listing and Conservation Status

Dwarf bear-poppy is a perennial herb listed as endangered pursuant to the ESA in December 1979. When the species was listed, primary threats were urban development, lack of regulatory mechanisms, and collection for home gardens. Current threats still include urban development, but collection is no longer considered a threat. Additional threats include habitat fragmentation, strip mining, grazing. Off-highway vehicle use, prolonged droughts, and climate change effects such as increased competition from invasive species and increased fire frequency and altered fire behavior (USFWS 2013d, 1979). Because potential habitat exists within the WTS, past activities related to WTS construction and surface disturbance may have impacted this species, but there is no available information concerning population numbers prior to activities related to the construction of the WTS. Critical habitat has not been designated for this species. In 2011, dwarf bear-poppy was recommended for a 5-year review with 11 other Mountain-Prairie Region species to revisit listing status (USFWS 2011). A recovery plan was completed in 1985 (USFWS 1985).The results of the 5-year review have not been published. The primary objective of the recovery plan is to restore the dwarf bear-poppy to a non-endangered status by protecting existing populations from threats and ensuring they are maintained as self-sustaining populations in their natural habitat (USFWS 1985).

3.9.3.3.2 Gierisch Mallow

3.9.3.3.2.1 Species Occurrence

Critical habitat for Gierisch mallow exists along the WTS, but it is unknown if occurrences are within the analysis area of the WTS. Habitat for this species is limited to desert scrub communities, on gypsum outcrops associated with the Harrisburg Member of the Kaibab Formation in northern Mohave County, Arizona, and closely adjacent Washington County, Utah. The species known range has not changed since it was described by the USFWS in 2002 (USFWS 2013b).

3.9.3.3.2.2 Life History and Habitat Association

Gierisch mallow grows within Mojave Desert scrub communities restricted by certain gypsum soils. The USFWS examined locations to identify commonalities such as slope, aspect, and occurrence locations. However, no correlation was determined. Populations are found between 2,477 and 3,766 feet amsl (USFWS 2013b). Very little is known about the species including pollination system, seed dispersal mechanisms, or conditions under which seeds germinate (USFWS 2015b).

3.9.3.3.2.3 Listing and Conservation Status

Gierisch mallow is a perennial listed as endangered pursuant to the ESA in September 2013. Threats to this species include livestock grazing, habitat loss and degradation from mining, recreational activities, and invasive plant species (USFWS 2013b). Because known locations and critical habitat exist within the WTS, past activities related to WTS construction and surface disturbance may have impacted this species, but there is no available information concerning population numbers prior to these activities. Small population size and a restricted range make this species increasingly susceptible to further declines (USFWS 2013c). No recovery information or conservation plans are available for Gierisch mallow (USFWS 2015b).

3.9.3.3.3 Holmgren Milk-vetch

3.9.3.3.3.1 Species Occurrence

Holmgren milk-vetch is an herbaceous perennial having known occurrences within critical habitat along the WTS in three small populations in Washington County, Utah, and Mohave County, Arizona. Individual plant numbers vary considerably from year-to-year (USFWS 2015c). These populations all occur within approximately 10 miles of St. George, Utah, with the largest concentration along the Utah-Arizona border. While this represents the known historic distribution, it is likely that due to human-induced impacts, Holmgren milk-vetch occupied more habitat in the past (USFWS 2006).

3.9.3.3.3.2 Life History and Habitat Association

The species grows within warm-desert shrub communities among small and large hill and plateau formations, above or at the edge of intermittent drainages. They are found on bare soils with less than 20 percent vegetated cover. Associated species include desert goldenhead (*Acamptopappus sphaerocephalus*), white burrobush (*Ambrosia dumosa*), Nevada jointfir (*Ephedra nevadensis*), threadleaf snakeweed (*Gutierrezia microcephala*), small flowered milk-vetch (*Astragalus nuttallianus*), and big galleta (*Hilaria rigida*). Approximately 95 percent of these plants occur on slopes of 20 percent or less. The soil surface for Holmgren milk-vetch is characterized by small stone and gravel deposits between 2,480 and 3,000 feet amsl (USFWS 2006). The species flowers between March and April (USFWS 2015c). Approximately half of the areas inhabited by this species are owned and managed by the State of Utah (USFWS 2006).

3.9.3.3.3.3 Listing and Conservation Status

Holmgren milk-vetch was listed as endangered pursuant to the ESA in September 2001. Threats to this species include urban development, off-road vehicle use, invasive plants, and mineral development (USFWS 2006). Past disturbance was shown to increase invasive weeds within habitat occupied by the species (USFWS 2006). Because known locations and critical habitat exist within the WTS, past activities related to WTS construction and surface disturbance may have impacted this species, but there is no available information concerning population numbers prior to these activities. Critical habitat exists for Holmgren milk-vetch (USFWS 2015c) and a recovery plan was completed in 2006 (USFWS 2006). Recovery for this species would hinge on conservation of extant populations as well as the establishment of additional populations to ensure demographic and genetic viability. Delisting potentially would occur when all of the recovery goals and criteria listed in the recovery plan are met (USFWS 2006).

3.9.3.3.4 Jones Cycladenia

3.9.3.3.4.1 Species Occurrence

Potential habitat for Jones cycladenia exists along the WTS. Jones cycladenia is known from 26 sites located in 5 areas in southern Utah (Kane, Grand, Garfield, and Emery counties) and northern Arizona (Mohave County) (USFWS 2008a).

3.9.3.3.4.2 Life History and Habitat Association

Jones cycladenia is a long-lived herbaceous perennial adapted to harsh soil conditions that are easily degraded by surface disturbance and is slow to recover (USFWS 1986a). The species grows within desert shrub and pinyon-juniper communities often associated with buckwheat and Mormon tea. It is found on gypsiferous, saline soils of the Cutler, Chinle, and Summerville Formations between 4,390 and 6,000 feet amsl. The species flowers from mid-April to early June (USFWS 2010).

3.9.3.3.4.3 Listing and Conservation Status

Jones cycladenia was listed as threatened pursuant to the ESA in May 1986. Threats to this species include cattle grazing, habitat disturbance from oil and gas development, tar sand and minerals exploration, and recreational or other off-road vehicle use. Habitat disturbance was thought to be reducing seedling establishment (USFWS 2008a). Because potential habitat exists within the WTS, past activities related to WTS construction and surface disturbance may have impacted this species, but there is no available information concerning population numbers prior to these activities. Designated critical habitat does not exist for Jones cycladenia. No recovery plan has been written, but a recovery plan is being prepared and recovery efforts are in progress. A recovery outline was created for the species which lays out the preliminary course of action for recovery (USFWS 2015f, 2008a). This species has been assigned a recovery priority of 12C, which indicates it faces a moderate degree of threat, has a low potential for recovery, and is in conflict with development or other economic activities. The initial action plan includes surveys and monitoring, threats abatement, and research (USFWS 2008a).

3.9.3.3.5 Siler Pincushion Cactus

3.9.3.3.5.1 Species Occurrence

Siler pincushion cactus has potential habitat along the WTS. The range of Siler pincushion cactus extends from extreme northwestern Coconino County, Arizona, west for approximately 70 miles into north-central Mohave County, Arizona. The range also includes approximately 3 miles within southern Utah in both Washington and Kane counties. The majority occur on BLM lands (Arizona Strip and Cedar City Districts). A smaller amount of land where the cactus is found is managed by the Kaibab-Paiute Indian Tribe, Arizona, Utah State trust lands, and privately owned lands (USFWS 2008b).

3.9.3.3.5.2 Life History and Habitat Association

Siler pincushion cactus grows in a variety of plant communities from 2,800 to 5,400 feet amsl, with low elevation sites within Mojave Desert scrub to the highest elevation sites within the Great Basin conifer woodland and Plains and Great Basin grassland communities (USFWS 1993). The majority are found in the Great Basin desert shrub community. The majority of plants are associated with the Shnabkaib Member of the Moenkopi Formation, which is composed of siltstone, gypsum, limestone, and dolomite. They also are found scattered on the Middle Red Member of the Moenkopi Formation, which is a reddish siltstone with thin to thick layers of gypsum (USFWS 2008b). Flowers appear in the spring (USFWS 1993).

3.9.3.3.5.3 Listing and Conservation Status

Siler pincushion cactus was listed as endangered in 1979 and reclassified as threatened pursuant to the ESA in 1993. It also is a BLM sensitive plant. Threats to this species include gypsum mining, off-road vehicle use, road construction, collection, livestock grazing, and inadequacy of regulatory mechanisms. Because known occurrences exist within the WTS, past activities related to WTS construction and surface disturbance may have impacted this species, but there is no available information concerning population numbers prior to these activities. Specialized soil types, small populations, and population disjunction could have intensified impacts to the species and its habitat (USFWS 1993). At the time of listing, there was thought to be less than 1,000 individuals. Since then, the BLM has performed extensive surveys as well as habitat delineation. As of 2008, it was estimated that over 34,000 acres of habitat exist and over 10,000 individuals have been recorded (USFWS 2008b). This is most likely a reflection of increased survey rather than increased individual plants. Based on USFWS monitoring data, populations are decreasing and showing evidence of reduced recruitment (USFWS 2008b). Critical habitat has not been designated for this species. A recovery plan was completed in 1986 (USFWS 1986b) and a 5-year review occurred in 2008 (USFWS 2008b).

3.9.4 Environmental Consequences

3.9.4.1 Issues

The following issues related to vegetation resources were identified through public and agency scoping. Although there is overlap, issues vary somewhat by project component.

3.9.4.1.1 Navajo Generating Station

Issue 1 – Operations and Maintenance, including Surface Disturbance - effects of operations and maintenance of NGS and associated facilities, including the BM&LP Railroad, on special status plants.

Issue 2 – Emissions and Deposition - effects of NGS emissions and metals deposition on special status plants.

3.9.4.1.2 Proposed Kayenta Mine Complex

Issue 1 – Operations and Reclamation - effects of mining operations and reclamation on special status plants.

Issue 2 – Emissions and Deposition - effects of combined emissions from the proposed KMC and NGS on special status plants.

Issue 3 – Groundwater Pumping - effects of mine-related groundwater pumping from the N-Aquifer on associated stream and spring baseflows that support special status plants.

3.9.4.1.3 Transmission Systems and Communication Sites

Issue 1 – Operations and Maintenance - effects of transmission line operations and maintenance on special status plants.

3.9.4.2 Assumptions and Impact Methodology

The following is a list of assumptions made and methodology used to assess impacts of the project as they relate to special status plant species.

- Potential habitat for special status plants was derived based on life history information and input from cooperating agencies.
- Species were considered as having the potential to occur within the study area if recent occurrence has been documented or the current range exists within the study area with suitable habitat present.
- There would be no construction disturbance for the BM&LP Railroad, transmission lines, and communication site. The analysis of impacts to special status plants from these components would be limited to O&M activities.
- Non-native and invasive plants are present within the project area.

3.9.4.2.1 Navajo Generating Station

- The NGS Near-field study area ERA (Ramboll Environ 2016a) evaluated risks to species within the 20-km deposition area of the NGS. Exposure of special status plants to COPECs (metals, dioxins/furans, and polycyclic aromatic hydrocarbons) was evaluated based on concentrations present in soil. Other cumulative sources, as well as future emissions from the NGS, also were modeled and evaluated from 2020 to 2074 to address future emissions deposition-related impacts from the Proposed Action and other sources.
- Only aquatic receptors along the Colorado and San Juan rivers were analyzed. No special status plants are riverine aquatic species; therefore, special status plants were not analyzed in the Gap Regions and San Juan River ERAs.
- HQs were used to identify risk effects to soil resources where special status plants potentially occur.
- Prior to vegetation treatments within the BM&LP railroad, potentially suitable habitat for special status plants would be surveyed and any occurrence locations marked to avoid impacts. Vegetation treatment would include activities such as mowing and weed control as outlined in the O&M plan.

3.9.4.2.2 Proposed Kayenta Mine Complex

- Known and potential special status plant occurrence was based on input from the Navajo Nation Department of Fish and Wildlife, USFWS, and PWCC.
- Waterbodies including seeps/springs within the N-Aquifer study area could be potential habitat for some special status plants. Groundwater modeling results were used to identify waterbodies where baseflow to springs could be reduced as a result of mine pumping.

3.9.4.2.3 Transmission Systems and Communication Sites

- Potential impacts from O&M activities to known or potential habitat occurrence of special status plants along the WTS and STS were evaluated qualitatively. Potential habitat locations were determined based on life history information and consultation with cooperating agencies.
- The indirect effects of introduction and spread of noxious weeds from vehicles or workers from infested areas into undisturbed areas were evaluated qualitatively. BMPs to reduce the spread of invasive plants are in place and would continue to be implemented to minimize impacts.
- Prior to vegetation treatments within the rights-of-way (ROWs) or other ground-disturbing maintenance activities, potentially suitable habitat for special status plants would be surveyed and any occurrences locations marked to avoid impacts. Vegetation treatment would include activities such as mowing and weed control as outlined in the O&M plan.

3.9.4.3 Proposed Action

3.9.4.3.1 Navajo Generating Station

3.9.4.3.1.1 Operations and Maintenance, including Surface Disturbance

Federally Listed Species

At the NGS, the Proposed Action would result in approximately 199 to 239 acres of surface disturbance (depending on 3-Unit Operation or 2-Unit Operation), resulting in the direct removal of primarily desert scrub vegetation. Of the three federally listed plants found within the NGS Near-field study area, Fickeisen plains cactus inhabits desert scrub communities, but is restricted to certain soils. As a result, this species is not likely to be found in the future NGS disturbance areas. However, special status plant species surveys would be conducted in these areas prior to disturbance to determine presence/absence of special status species. If special status plants are found, consultation would occur with the U.S. Fish and Wildlife Service.

Welsh's milkweed, a federally threatened species, has the potential to occur along the BM&LP Railroad. Coal dust generated during coal transport (i.e., along the BM&LP Railroad), handling, and storage could settle on vegetation, potentially resulting in a localized effect to plant health including Welsh's milkweed. The potential for untreated or improperly loaded coal to be lost due to wind erosion is greatest during the initial transport near the mine (Winges and Steffel 2016).

Potential impacts from fugitive dust under the Proposed Action would be minimized through the implementation of fugitive dust control measures described in the NGS Operations and Maintenance Plan (**Appendix 1B**). Measures implemented to reduce coal blow-off during transport would include ensuring the coal remains below the top of the train cars during loading and enforcing slow train speeds. To further reduce the generation of coal dust, NGS developed a Dust Control Plan that would continue to be implemented at the plant and associated facilities. In addition, an annual Fugitive Dust Control Report that describes actions taken to control dust, records of citizen complaints, and any corrective measures taken for the Ash Disposal Area also would be generated as required under coal combustion residual regulations (40 Code of Federal Regulations 257.80). Based on implementation of these measures, dust-related effects to Welsh's milkweed from O&M activities would be negligible.

Under the Proposed Action, the majority of the operating and support facilities at NGS would be dismantled and properly disposed and the area reclaimed at the end of operations, unless the Navajo Nation continues NGS operations beyond 2044. **Appendix 1B** provides an overview of the decommissioning sequence for the plant and associated facilities, including the coal ash landfill and BM&LP Railroad. Under this alternative, approximately 3,724 acres associated with the plant, coal ash landfill, and BML&LP Railroad, would be reclaimed.

Potential Welsh's milkweed habitat near the BM&LP Railroad Welsh's milkweed would be marked and avoided to minimize any impacts to special status plants during decommissioning and abandonment of the railroad. The implementation of additional reclamation techniques such as minimization of surface disturbance, soil amendments, and noxious weed control may be required along the BM&LP Railroad to further minimize impacts to special status plants or potential habitat. Decommissioning and abandonment of the railroad should have negligible effects to special status plants.

<u>Other Special Status Plant Species</u>

Kaibab plains cactus and Mojave indigo bush have the potential to occur along the BM&LP Railroad and are listed on **Table 3.9-2**. As discussed above for the Welsh's milkweed, there would be negligible dust-related effects to these species as a result of O&M activities. Also, decommissioning and abandonment of the railroad should have negligible effects on these species with implementation of the measures discussed above for federally listed plants.

3.9.4.3.1.2 Emissions and Deposition

<u>Federally Listed Species</u>

Federally listed plants found within the NGS Near-field study area are listed in **Table 3.9-2**. For the NGS ERA emissions analysis, potential emissions/deposition-related effects to special status plants were evaluated by comparison of soil concentrations for each COPEC to baseline soil concentrations plus air deposition (to soil) considering both the 3-Unit Operation and 2-Unit Operation (see Section 3.9.3.1 for further detail). Based on the results of the NGS ERA analysis, the 3-Unit Operation and 2-Unit Operation would result in HQs below 1 from emission deposition (Ramboll Environ 2016a). Therefore, the Proposed Action would have negligible effects on special status plant species.

<u>Other Special Status Plant Species</u>

Other special status plant species having known locations or potential habitat within the NGS Near-field study area are listed in **Table 3.9-2**. Potential emissions/deposition-related effects to other special status plant species were evaluated based on the soil concentrations for each COPEC reported in the NGS ERA. Based on the results of the NGS ERA, the 3-Unit Operation and 2-Unit Operation would result in HQs below 1 (Ramboll Environ 2016a). Therefore, the Proposed Action would have negligible effects to alcove death camas, Mojave indigo bush, Kaibab plains cactus, and Marble Canyon milk-vetch from future operations of NGS.

3.9.4.3.2 Proposed Kayenta Mine Complex

3.9.4.3.2.1 Operations and Reclamation

<u>Federally Listed Species</u>

No federally listed plants have known locations or potential habitat within the proposed KMC study area. Surveys were conducted in lease areas N-10 and J-28 which support no occurrences or potential habitat of federally listed plants (ESCO and PWCC 2003). Suitable habitat was not identified in the other lease areas based on examination of aerial imagery and baseline vegetation data (ESCO and PWCC 2003).

Therefore, there would be no disturbance-related impacts to federally listed plants in the KMC study area.

Other Special Status Plant Species

No other special status plant species have known occurrences or potential habitat within the proposed KMC study area. Therefore, there would be no disturbance-related impacts on other special status plants.

3.9.4.3.2.2 Emissions and Deposition

The KMC ERA study area encompasses areas within and outside of the KMC study area (**Figure 3.0-8**). For the KMC ERA emissions analysis, the potential for ecological risk was evaluated by comparison of soil concentrations for each COPEC to baseline soil concentrations plus air deposition (to soil) considering both the 3-Unit Operation and 2-Unit Operation. The resulting HQs were below 1 (Ramboll Environ 2016g) indicating that ecological risk in the KMC ERA study area is not likely. Therefore, it is anticipated there would be negligible risk to federally listed and other special status plant species.

3.9.4.3.2.3 Groundwater Pumping

Federally Listed Species

Critical habitat as well as potentially suitable habitat for the Navajo sedge exists within the N-Aquifer study area. This species occurs among hanging garden communities affiliated with seeps/springs. Due to potential drawdown effects from mine pumping within the N-Aquifer, groundwater modeling was conducted for eight geographical groups of springs to determine if project pumping could affect spring outflows. Details of this analysis are provided in Section 3.7, Water Resources. The model results predict that spring flow reduction from project groundwater pumping could occur in three of the spring groups in the N-Aquifer study area (i.e., near Tuba City/Moenkopi Wash, Chinle, and Dennehotso). There are known locations and potential habitat of Navajo sedge located within two of the three spring groups, including the F1 spring group near Dennehotso and the I spring group near Chinle. The model analysis estimated small flow reductions from less than 0.001 to approximately 0.06 gallons per minute. For most spring groups, simulated changes in hydraulic head (water level at the ground surface) generally ranged from zero to approximately 0.02 feet. Immediately west of Chinle, the head change ranged up to about 0.1 foot. At the four U.S. Geological Survey-monitored springs, there would be no change in flow as a result of project pumping under the Proposed Action. Based on the groundwater model results, it is expected the changes in water level at the ground surface from mine pumping would have negligible effects to the Navajo sedge at seeps/springs in the N-Aquifer study area.

The occurrence of Navajo sedge near Tsegi Canyon is likely supported by recharge to exposed Navajo sandstone from the north, as opposed to groundwater discharge from the N-aquifer to the south (OSMRE 2011). When precipitation falls on the exposed Navajo sandstone in the Tsegi Canyon, some water travels through cracks and discharges from the canyon walls. These water discharges are enough to support hanging garden communities. Groundwater pumping cannot occur above the Laguna Creek saturated alluvium and, therefore, would not have an effect on the population of Navajo sedge at Tsegi Canyon (OSMRE 2011).

Other Special Status Species

Alcove bog orchid and alcove death camas have potential habitat within the N-Aquifer study area. These species occur in hanging garden communities associated with seeps/springs. Potential reduction in groundwater baseflows to seep/spring habitats for these species would be the same as those described above for the Navajo sedge. Based on the groundwater model results, it is expected the changes in water level at the ground surface as a result of mine pumping would have negligible effects to the alcove bog orchid and alcove death camas at seeps/springs in the N-Aquifer study area.

3.9.4.3.3 Transmission Systems and Communication Sites

3.9.4.3.3.1 Operations and Maintenance

Federally Listed Species

Federally listed plants with known or potential habitat along the WTS and STS are displayed in **Table 3.9-4**.

The majority of inspection and maintenance activities would occur along the existing ROWs, serviced by existing roads leading to the regional highway system. Potential impacts to federally listed plants as a result of O&M activities would include erosion and sedimentation caused by maintenance vehicles, fugitive dust generation, and the spread and establishment of noxious or invasive weeds into areas of lower vegetative cover. Special status species surveys and avoidance measures would be required prior to any new surface disturbance (excluding emergency maintenance activities). Further discussion outlining specific vegetation maintenance within the WTS and STS are described in the NGS Operations and Maintenance Plan (**Appendix 1B**). There would be negligible effects to dwarf-bear poppy, Fickeisen plains cactus, Jones cycladenia, Siler pincushion cactus, and Welsh's milkweed from O&M activities based on continued implementation of BMPs.

Gierisch mallow critical habitat is crossed by the WTS ROW approximately 9 miles southeast of St. George, Utah. It is not known if individual plants are within the critical habitat crossed by the WTS study area or ROW. Several access roads affiliated with the WTS also are within this critical habitat. Conservation measures for this species would reduce the likelihood of direct impacts to this species by requiring that biologically sensitive areas be marked and avoided, and that pre-activity surveys be conducted prior to vegetation management occurring in the ROW in these areas. In addition, vehicle use would be restricted to existing roads in areas of suitable habitat.

Although suitable or critical habitat for Gierisch mallow may be affected by the introduction and spread of noxious weeds or invasive plant species, ongoing conservation measures require clean vehicle practices during O&M activities. Also, the WTS ROW has been altered and exhibits disturbance due to ongoing maintenance and vegetation management activities. Therefore, it is anticipated that continued O&M activities would have negligible effects on suitable or critical habitat for the Gierisch mallow.

Holmgren milk-vetch is known to occur within designated critical habitat approximately 0.7 to 3.5 miles from the WTS ROW in both Washington County, Utah, and Mohave County, Arizona. Suitable habitat is present within the WTS study area and critical habitat for this species is crossed by the WTS study area; however, it is not known if individual plants are present in these locations. One WTS ROW access road goes through Holmgren milk-vetch critical habitat, while one access road is immediately adjacent and shares a boundary with critical habitat. Conservation measures for this species would reduce the likelihood of direct impact to this species by requiring that biologically sensitive areas be marked and avoided, and that pre-activity surveys are conducted prior to vegetation management occurring in the ROW in these areas. In addition, vehicle use would be restricted to existing roads in areas of suitable habitat.

Although suitable and critical habitat for Holmgren milk-vetch may be affected by the introduction and spread of noxious weeds or invasive plant species, ongoing conservation measures require clean vehicle practices during O&M activities. Also, the WTS ROW is altered and exhibits disturbance due to ongoing maintenance and vegetation management activities. Therefore, it is anticipated that continued O&M activities would have negligible effects on suitable or critical habitat for Holmgren milk-vetch.

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

Other Special Status Plant Species

Other special status plant species with known locations or potential habitat along the WTS and STS are listed in **Table 3.9-4**. Potential impacts to these species resulting from transmission line O&M activities would be the same as those described above for federally listed species. It is anticipated that the Proposed Action would result in negligible effects to other special status plants with continued implementation of conservation measures during O&M activities.

3.9.4.3.4 Project Impact Summary – All Project Components

The total surface disturbance under the Proposed Action would be between 5,527 and 4,998 acres. The overall effects of the Proposed Action on special status plants would be considered negligible.

Up to 239 acres of vegetation will be removed at the NGS plant and ash disposal site. However, due to the unlikely occurrence of special status plants within the future disturbance areas and the conduct of pre-disturbance surveys, no disturbance-related impacts to special status plants are anticipated at the NGS plant site. Effects to special status plants as a result of O&M activities at NGS and along the BM&LP Railroad and transmission systems are expected to be negligible.

NGS emissions and deposition by itself would represent a negligible risk to special status plants in the NGS Near-field study area, as indicated by HQs less than 1. When combining NGS emissions with baseline conditions, there would be a negligible risk to special status plants based on HQ values less than 1. The KMC ERA indicates emissions from the proposed KMC would pose a negligible risk to special status plants in the KMC ERA study area based on HQ values that are less than 1.

Water pumping in the proposed KMC would result in small baseflow reductions to seeps and springs, representing negligible impacts to special status plants and habitat.

3.9.4.3.5 Cumulative Impacts

The special status plants cumulative effects study areas are the same as the direct indirect study areas. Refer to Section 3.0 for a detailed description of these study areas. Cumulative impacts occur when the incremental effects of an action are added with the effects of other past and present actions and reasonably foreseeable future actions.

3.9.4.3.5.1 Operations and Maintenance, including Surface Disturbance

Reasonably foreseeable future actions are anticipated to impact 4,201 acres of vegetation, and past and present actions have impacted approximately 52,786 acres of vegetation. It is not known if special status plants were impacted, or would be impacted, by these actions. The Proposed Action incrementally would contribute between 4,998 and 5,527 acres of vegetation disturbance to cumulative impacts, resulting in a total cumulative impact to vegetation on between 61,985 and 62,514 acres. The Proposed Action's contribution to cumulative impacts to special status plants, critical habitat, and potentially suitable habitat within the project disturbance area would be considered negligible with implementation of conservation measures and BMPs. It is anticipated that reclamation of portions of past and present actions and reasonably foreseeable future actions have been, or would be, completed in accordance with permit requirements or lease agreements, thereby reducing the cumulative impact to vegetation (and potentially special status plant species and habitat, if present) over time. Reclamation of Proposed Action disturbance areas would further minimize the project's contribution to cumulative special status species impacts.

3.9.4.3.5.2 Emissions and Deposition

Cumulative special status species impacts resulting from past and present emissions and deposition in the cumulative effects study area are reflected in the NGS Near-field ERA and KCM ERA baseline COPECs analyses. The ERAs also evaluated future ecological risk from ongoing emissions and deposition. Based on the ERA results, the HQs for both baseline and future conditions indicate an ecological risk below 1, indicating that ecological risk to special status species is not likely under either scenario. Therefore, the project's contribution to cumulative ecological risk for special status plants would be negligible and would cease following completion of operations in 2044.

3.9.4.3.5.3 Groundwater Pumping

Past and present and reasonably foreseeable future actions that could contribute to drawdown related effects to seeps/springs that support Navajo sedge, alcove bog orchid, or alcove death camas or provide habitat for these species within the N-Aquifer study area include groundwater pumping from community wells for local water use. Groundwater modeling indicates special status plants associated with seeps and springs that have hydraulic connection to the N-Aquifer could experience negligible to minor effects as groundwater levels decline from community pumping in future years. The modeling also indicates that the Proposed Action's contribution to groundwater level declines and associated effects to seeps and springs that support, or may support, these species would be negligible.

3.9.4.4 Natural Gas Partial Federal Replacement Alternative

Under the Natural Gas Partial Federal Replacement (PFR) Alternative, a selected quantity of power between 100 megawatts (MW) and 250 MW would be contracted for under a long-term power purchase agreement from currently unidentified, existing natural gas generation sources, displacing an equivalent amount of power from the federal share of NGS generation. Because the facility is assumed to exist, prior disturbance impacts to special status plants at the existing facility are not evaluated in this Environmental Impact Statement (EIS). Key assumptions about special status plants related to such an existing natural gas site are listed below.

- The natural gas plant underwent National Environmental Policy Act (NEPA) evaluation.
- A combined-cycle natural gas power plant would typically be located on a site of approximately 100 acres. No additional surface disturbance would be required over time.
- Native vegetation and possibly special status plants were removed from the site and would not be revegetated until after facility decommissioning.
- Natural gas combustion for power generation would not result in COPEC emissions and deposition that would overlap with the coal combustion emissions and deposition from NGS in the study area. The description of emission calculations for the PFR are described in Chapter 2.0 and in Section 3.1, Air Quality.

3.9.4.4.1 Navajo Generating Station

3.9.4.4.1.1 Operations and Maintenance, including Surface Disturbance

Federally listed and other special status plants that have occurrences or potential habitat are listed in **Table 3.9-2**. Coal delivery under the Proposed Action would range between 5.5 million tons per year (tpy) and 8.1 million tpy. Under the Natural Gas PFR Alternative, less coal would be handled and transported on the BM&LP Railroad because less power would be generated. **Table 3.0-6** shows the difference in annual coal production and use. The reductions in coal use would be between 5 and 18 percent annually under the Natural Gas PFR Alternative. Overall, impacts to special status plants as a result of surface disturbance and O&M activities under this alternative would be similar to the Proposed Action and, therefore, would be negligible.

3.9.4.4.1.2 Emissions and Deposition

COPECs, specifically selenium, arsenic and mercury, associated with the Natural Gas PFR Alternative NGS stack emissions would be reduced relative to the Proposed Action as presented in **Table 3.9-5.**

Table 3.9-5 Emissions Reductions of Selenium, Mercury, and Arsenic Under the Natural Gas PFR Alternative

Trace Metals	Proposed Action Emissions (tpy)		Natural Gas PFR 100-MW Power Reduction (tpy / %change)	Natural Gas PFR 250-MW Power Reduction (tpy / %change)
Selenium	3-Unit	2.237	2.127 / -5%	1.957 / -13%
Selenium	2-Unit	1.491	1.377 / -8%	1.208 / -19%
Mercury (total)	3-Unit	0.117	0.111 / -5%	0.102 / -13%
Mercury (total)	2-Unit	0.078	0.072 / -8%	0.063 / -19%
Arsenic	3-Unit	0.133	0.127 / -5%	0.117 / -13%
Arsenic	2-Unit	0.089	0.083 / -8%	0.073 / -19%

The 3-Unit Operation and 2-Unit Operation 100-MW and 250-MW Natural Gas PFR Alternative operations would result in approximately 5 to 19 percent less selenium, arsenic, and mercury than the Proposed Action. Based on modeling for the Proposed Action, maximum deposition from the NGS stacks combined with background soil concentrations would be below U.S. Environmental Protection Agency ERA screening levels as described under the Proposed Action.

Federally listed and other special status plants that have known occurrences or potential habitat within the NGS Near-field study area are listed in **Table 3.9-2**. The emission/deposition-related impacts on these species under the Natural Gas PFR Alternative and the Proposed Action would be similar because the Proposed Action ERA analysis indicates HQ numbers less than 1, indicating negligible risk.

3.9.4.4.2 Proposed Kayenta Mine Complex

3.9.4.4.2.1 Operations and Reclamation

There are no special status plants that have known occurrences or potential habitat within the proposed KMC study area. Therefore, there would be no disturbance-related impacts to special status plants under this alternative.

3.9.4.4.2.2 Emissions and Deposition

Under the Natural Gas PFR Alternative, less coal would be produced than under the Proposed Action, resulting in a reduction in mining-related emissions deposition. However, the emission/deposition-related impacts on federally listed and other special status species under the Natural Gas PFR Alternative and the Proposed Action would be similar because the Proposed Action ERA analysis indicates HQ numbers less than 1, indicating negligible risk.

3.9.4.4.2.3 Groundwater Pumping

Navajo sedge is a federally listed plant having known occurrences and critical habitat within the N-Aquifer study area. Other special status plants (i.e., alcove bog orchid and alcove death camas) listed in **Table 3.9-3** have potential habitat in the N-Aquifer study area. These species are present among the hanging garden communities affiliated with seeps/springs. Due to potential drawdown effects from water pumping within the N-Aquifer, groundwater modeling was conducted for eight geographical groups of springs to determine if project pumping could affect spring outflows. Details for this analysis are provided in Section 3.7, Water Resources. Water use would be the same under both the Natural Gas PFR Alternative and the Proposed Action; therefore, effects to special status plants and habitat at the seeps and springs in the N-Aquifer study area under this alternative also would be negligible. For more discussion, see Section 3.9.4.3, Proposed Action, *Proposed Kayenta Mine Complex*.

3.9.4.4.3 Transmission Systems and Communication Sites

3.9.4.4.3.1 Operations and Maintenance

Federal and other special status plants found within the WTS and STS are listed in **Table 3.9-4**. O&M activities along the WTS and STS and at the communications sites would be the same as the Proposed Action (Section 3.9.4.3). There would be negligible effects to dwarf-bear poppy, Fickeisen plains cactus, Jones cycladenia, Siler pincushion cactus, and Welsh's milkweed within the WTS and STS ROWs under the Natural Gas PFR Alternative from O&M activities based on continued implementation of BMPs. There would be negligible effects to Gierisch mallow and Holmgren milk-vetch, as well as their respective critical habitats, with implementation of conservation measures and BMPs.

3.9.4.4.4 Project Impact Summary – All Project Components

The overall effects of the Natural Gas PFR Alternative on special status plant species is expected to be negligible due to the overall effect of the various impact issues.

The Natural Gas PFR Alternative would result in a 5 to 19 percent power reduction at NGS compared to the Proposed Action, and reductions in coal production at the proposed KMC would result in an approximate 5 to 18 percent reduction in surface disturbance. These reductions would result in lower emissions and deposition of COPECs within the study area and an anticipated slight reduction in the HQs. Based on the NGS Near-field ERA and KMC ERA evaluations, the HQs under the Proposed Action were determined to be less than 1, indicating a negligible risk to special status plants. The ecological risk to vegetation under the Natural Gas PFR Alternative also would be considered negligible.

O&M activities for the BM&LP Railroad and transmission systems also would result in negligible impacts to special status plants as well as Gierisch mallow and Holmgren milk-vetch critical habitat.

Groundwater pumping at the proposed KMC would result in small baseflow reductions to seeps and springs, representing negligible effects on special status species and habitat.

3.9.4.4.5 Cumulative Impacts

The cumulative impacts of surface disturbance under the Natural Gas PFR Alternative would be 0 to 1 percent less than those estimated for the Proposed Action. The surface disturbance contributed by the Natural Gas PFR Alternative, past and present actions, and foreseeable future actions is estimated to be between 62,252 to 61,132 acres. Reclamation of Natural Gas PFR Alternative disturbance areas would minimize the project's contribution to cumulative special status species impacts over time.

Cumulative special status plants impacts resulting from past and present emissions and deposition in the cumulative effects study area are reflected in the NGS Near-field ERA and KCM ERA baseline COPECs analyses. The ERAs also evaluated future ecological risk from ongoing emissions and deposition. Based on the ERA results for the Proposed Action, the HQs for both baseline and future conditions indicate an ecological risk below 1, indicating that ecological risk to special status plants is not likely under either scenario. Although the Natural Gas PFR Alternative would result in a slight reduction in emissions deposition, the project's contribution to cumulative ecological risk for special status plants would be considered negligible and would cease following completion of operations in 2044.

Cumulative impacts to special status plants as a result of groundwater pumping-related drawdown in the N-Aquifer under the Natural Gas PFR Alternative would be the same as discussed in the Proposed Action cumulative impacts sections. As discussed, groundwater modeling indicates special status species associated with seeps and springs that have hydraulic connection to the N-Aquifer could experience negligible to minor effects as groundwater levels decline from community pumping in future years. The modeling also indicates that the Proposed Action's contribution to groundwater level declines and associated effects to seeps and springs that support, or may support, these species would be negligible. As the water usage would be the same under both the Natural Gas PFR Alternative and the

Proposed Action, the project's contribution to cumulative groundwater level declines under the Natural Gas PFR Alternative also would be negligible.

3.9.4.5 Renewable Partial Federal Replacement Alternative

Under the Renewable PFR Alternative, a selected quantity of power between 100 MW and 250 MW would be contracted for under a long-term power purchase agreement from a currently unidentified, existing renewable energy power source, displacing an equivalent amount of power from the federal share of NGS generation. Because the facility is assumed to exist, prior disturbance impacts to special status plants are not evaluated in this EIS. Key assumptions about special status plants related to such an existing site are listed below.

- The renewable energy operation underwent NEPA evaluation.
- A renewable energy power plant would typically be located on a site of approximately 100 acres. No additional surface disturbance would be required over time.
- Native vegetation and possibly special status plants were removed from the site and would not be revegetated until after facility decommissioning.
- Combustion and emissions for power generation would not result in COPEC emissions and deposition that would overlap with the coal combustion emissions and deposition from NGS in the study area. The description of emission calculations for the PFR are described in Chapter 2.0 and in Section 3.1, Air Quality.

3.9.4.5.1 Navajo Generating Station

3.9.4.5.1.1 Operations and Maintenance, including Surface Disturbance

Federally listed and other special status plants that have occurrences or potential habitat are listed in **Table 3.9-2**. Under the Renewable PFR Alternative, less coal would be handled and transported on the BM&LP Railroad because less power would be generated at NGS. **Table 3.0-6** shows the difference in annual coal production and use. The reductions in coal use are between 2 and 11 percent annually under the Renewable PFR Alternative. Overall, impacts to special status plants as a result of surface disturbance and O&M activities under this alternative would be similar to the Proposed Action and, therefore, would be negligible.

3.9.4.5.1.2 Emissions and Deposition

COPECs, specifically selenium, arsenic and mercury for the Renewable PFR Alternative NGS stack emissions, would be reduced relative to the Proposed Action as presented in **Table 3.9-6**.

The 3-Unit Operation and 2-Unit Operation 100-MW and 250-MW Renewable PFR Alternative operations would result in approximately 3 to 11 percent less selenium, arsenic, and mercury than the Proposed Action. Based on modeling for the Proposed Action, maximum deposition from the NGS stacks combined with background soil concentrations would be below U.S. Environmental Protection Agency ERA screening levels.

Federally listed and other special status plants that have known occurrences or potential habitat within the NGS Near-field study area are listed in **Table 3.9-2**. The emission/deposition-related impacts on these species under the Renewable PFR Alternative and the Proposed Action would be similar because the Proposed Action ERA analysis indicates HQ numbers less than 1, indicating negligible risk.

Table 3.9-6 Emissions Reductions of Selenium, Mercury, and Arsenic Under the Renewable PFR Alternative

Trace Metals	Proposed Action Emissions (tpy)	Renewable PFR 100-MW Power Reduction (tpy / %change)	Renewable PFR 250-MW Power Reduction (tpy / %change)
Selenium	3-Unit 2.237	2.174 / -3%	2.075 / -7%
Selenium	2-Unit 1.491	1.424 / -4%	1.325 / -11%
Mercury (total)	3-Unit 0.117	0.114 / -3%	0.108 / -7%
Mercury (total)	2-Unit 0.078	0.075 / -4%	0.069 / -11%
Arsenic	3-Unit 0.133	0.130 / -3%	0.124 / -7%
Arsenic	2-Unit 0.089	0.086 / -4%	0.080 / -11%

3.9.4.5.2 Proposed Kayenta Mine Complex

3.9.4.5.2.1 Operations and Reclamation

There are no special status plants that have known occurrences or potential habitat within the proposed KMC study area. Therefore, there would be no disturbance-related impacts to special status plants under this alternative.

3.9.4.5.2.2 Emissions and Deposition

Under the Renewable PFR Alternative, less coal would be produced than under the Proposed Action, resulting in a reduction in mining-related emissions deposition. However, the emission/deposition-related impacts on federally listed and other special status species under the Renewable PFR Alternative and the Proposed Action would be similar because the Proposed Action ERA analysis indicates HQ numbers less than 1, indicating negligible risk.

3.9.4.5.2.3 Groundwater Pumping

Navajo sedge is a federally listed plant having known occurrences and critical habitat within the N-Aquifer study area. Other special status plants (i.e., alcove bog orchid and alcove death camas) listed in **Table 3.9-3** have potential habitat in the N-Aquifer study area. These species are present among the hanging garden communities affiliated with seeps/springs. Due to potential drawdown effects from water pumping within the N-Aquifer, groundwater modeling was conducted for eight geographical groups of springs to determine if project pumping could affect spring outflows. Details for this analysis are provided in Section 3.7, Water Resources. Water use would be the same under both the Renewable PFR Alternative and the Proposed Action; therefore, effects to special status plants and habitat at the seeps and springs in the N-Aquifer study area under this alternative also would be negligible. For more discussion, see Section 3.9.4.3, Proposed Action, *Proposed Kayenta Mine Complex*.

3.9.4.5.3 Transmission Systems and Communication Sites

3.9.4.5.3.1 Operations and Maintenance

Federal and other special status plants found within the WTS and STS are listed in **Table 3.9-4**. O&M activities along the WTS and STS and at the communications sites would be the same as the Proposed Action (Section 3.9.4.3). There would be negligible effects to dwarf-bear poppy, Fickeisen plains cactus, Jones cycladenia, Siler pincushion cactus, and Welsh's milkweed within the WTS and STS ROWs under the Natural Gas PFR Alternative from O&M activities based on continued implementation of BMPs. There would be negligible effects to Gierisch mallow and Holmgren milk-vetch, as well as their respective critical habitats, with implementation of conservation measures and BMPs.

3.9.4.5.4 Project Impact Summary – All Project Components

The overall effects of the Renewable PFR Alternative on special status plants would be considered negligible due to the overall effect of the various impact issues.

The Renewable PFR Alternative would result in a 3 to 11 percent power reduction at NGS compared to the Proposed Action, and reductions in coal production at the proposed KMC would result in an approximate 3 to 10 percent reduction in surface disturbance. These reductions would result in lower emissions and deposition of COPECs within the study area and an anticipated slight reduction in the HQs. Based on the NGS Near-field ERA and KMC ERA evaluations, the HQs under the Proposed Action were determined to be less than 1, indicating a negligible risk to special status plants. The ecological risk to vegetation under the Renewable PFR Alternative also would be considered negligible.

O&M activities for the BM&LP Railroad and transmission systems also would result in negligible impacts to special status plants as well as Gierisch mallow and Holmgren milk-vetch critical habitat.

Groundwater pumping at the proposed KMC would result in small baseflow reductions to seeps and springs, representing negligible effects on special status species and habitat.

3.9.4.5.5 Cumulative Impacts

The cumulative impacts of surface disturbance under the Renewable PFR would be 0 to 1 percent less than those estimated for the Proposed Action. The surface disturbance contributed by the Renewable PFR Alternative, past and present actions, and foreseeable future actions is estimated to be between 62,356 and 61,511 acres. Reclamation of Renewable PFR Alternative disturbance areas would minimize the project's contribution to cumulative special status species impacts over time.

Cumulative special status species impacts resulting from past and present emissions and deposition in the cumulative effects study area are reflected in the NGS Near-field ERA and KCM ERA baseline COPECs analyses. The ERAs also evaluated future ecological risk from ongoing emissions and deposition. Based on the ERA results for the Proposed Action, the HQs for both baseline and future conditions indicate an ecological risk below 1, indicating that ecological risk to special status plants is not likely under either scenario. Although the Renewable PFR Alternative would result in a slight reduction in emissions deposition, the project's contribution to cumulative ecological risk for special status plants would be considered negligible and would cease following completion of operations in 2044.

Cumulative impacts to special status plants as a result of groundwater pumping-related drawdown in the N-Aquifer under the Renewable PFR Alternative would be the same as discussed in the Proposed Action cumulative impacts sections. As discussed, groundwater modeling indicates that special status plants associated with seeps and springs that have hydraulic connection to the N-Aquifer could experience negligible to minor effects as groundwater levels decline from community pumping in future years. The modeling also indicates that the Proposed Action's contribution to groundwater level declines and associated effects to seeps and springs that support, or may support, these species would be negligible. As the water usage would be the same under both the Renewable PFR Alternative and the Proposed Action, the project's contribution to cumulative groundwater level declines under the Renewable PFR Alternative also would be negligible.

3.9.4.6 Tribal Partial Federal Replacement Alternative

Under the Tribal PFR Alternative, between 100 MW and 250 MW of power generation from the NGS would be replaced by power supplied by a new photovoltaic generation facility on tribal land, displacing an equivalent amount of power from the federal share of NGS generation. The construction of a new photovoltaic generation site on tribal land would result in between 1,200 and 3,000 acres of new surface disturbance. The Tribal PFR facility would be analyzed in a separate NEPA process once a facility location is identified. Key assumptions about special status plants related to the construction of a new photovoltaic facility are listed below.

- Combustion emissions from firming power generation would not result in COPEC emissions and deposition that would overlap with the coal combustion emissions and deposition from NGS in the study area. The description of emissions calculations for the PFR is described in Chapter 2.0 and in Section 3.1, Air Quality.
- The duration of construction of a photovoltaic site would take between 1.5 and 3 years.
- The emissions caused from construction of the solar facility (fugitive dust and vehicles) could be located in the NGS study area but would be very localized and temporary.
- The construction of a photovoltaic site would be subject to subsequent evaluation through NEPA and ESA, where impacts to any special status plants would be analyzed.

3.9.4.6.1 Navajo Generating Station

3.9.4.6.1.1 Operations and Maintenance, including Surface Disturbance

Federally listed and other special status plants that have occurrences or potential habitat are listed in **Table 3.9-2**. Coal delivery under the Proposed Action would range between 5.5 million tpy and 8.1 million tpy. Under the Renewable PFR Alternative, less coal would be handled and transported on the BM&LP Railroad because less power would be generated. **Table 3.0-6** shows the difference in annual coal production and use. The reductions in coal use would be between 2 and 7 percent annually under the Tribal PFR Alternative. Overall, impacts to special status plants as a result of surface disturbance and O&M activities under this alternative would be similar to the Proposed Action and, therefore, would be negligible.

3.9.4.6.1.2 Emissions and Deposition

COPECs, specifically selenium, arsenic and mercury for the Tribal PFR Alternative NGS stack emissions would be reduced relative to the Proposed Action as presented in **Table 3.9-7**.

Table 3.9-7 Emissions Reductions of Selenium, Mercury, and Arsenic Under the Tribal PFR Alternative

Trace Metals	Proposed Action Emissions (tpy)	Tribal PFR 100-MW Power Reduction (tpy / %change)	Tribal PFR 250-MW Power Reduction (tpy / %change)
Selenium	3-Unit 2.237	2.174 / -3%	2.153 / -4%
Selenium	2-Unit 1.491	1.447 / -3%	1.383 / -8%
Mercury (total)	3-Unit 0.117	0.114 / -3%	0.111 / -5%
Mercury (total)	2-Unit 0.078	0.076 / -3%	0.072 / -8%
Arsenic	3-Unit 0.133	0.130 / -2%	0.128 / -4%
Arsenic	2-Unit 0.089	0.087 / -3%	0.084 / -6%

The 3-Unit Operation and 2-Unit Operation 100-MW and 250-MW Tribal PFR Alternative operations would result in approximately 2 to 8 percent less selenium, arsenic, and mercury than the Proposed Action. Based on modeling for the Proposed Action, maximum deposition from the NGS stacks combined with background soil concentrations would be below U.S. Environmental Protection Agency ERA screening levels since HQ values were less than 1.

Federally listed and other special status plants that have known occurrences or potential habitat within the NGS Near-field Area are listed in **Table 3.9-2**. The emission/deposition-related impacts on these species under the Tribal PFR Alternative and the Proposed Action would be similar because the Proposed Action ERA analysis indicates HQ numbers less than 1, indicating negligible risk.

3.9.4.6.2 Proposed Kayenta Mine Complex

3.9.4.6.2.1 Operations and Reclamation

There are no special status plants that have known occurrences or potential habitat within the proposed KMC. Therefore, there would be no impacts to special status plants as a result of surface disturbance from construction and mining operations.

3.9.4.6.2.2 Emissions and Deposition

Under the Tribal PFR Alternative, less coal would be produced than under the Proposed Action, resulting in a reduction in mining-related emissions deposition. However, the emission/deposition-related impacts on federally listed and other special status species under the Tribal PFR Alternative and the Proposed Action would be similar because the Proposed Action ERA analysis indicates HQ numbers less than 1, indicating negligible risk.

3.9.4.6.2.3 Groundwater Pumping

Navajo sedge is a federally listed plant having known occurrences and critical habitat within the N-Aquifer study area. Other special status plants (i.e., alcove bog orchid and alcove death camas) listed in **Table 3.9-3** have potential habitat in the N-Aquifer study area. These species are present among the hanging garden communities affiliated with seeps/springs. Due to potential drawdown effects from water pumping within the N-Aquifer, groundwater modeling was conducted for eight geographical groups of springs to determine if project pumping could affect spring outflows. Details for this analysis are provided in Section 3.7, Water Resources. Water use would be the same under both the Tribal PFR Alternative and the Proposed Action; therefore, effects to special status plants and habitat at the seeps and springs in the N-Aquifer study area under this alternative also would be negligible. For more discussion, see Section 3.9.4.3.2, *Proposed Kayenta Mine Complex*.

3.9.4.6.3 Transmission Systems and Communication Sites

3.9.4.6.3.1 Operations and Maintenance

Federal and other special status plants found within the WTS and STS are listed in **Table 3.9-4**. O&M activities along the WTS and STS and at the communications sites would be the same as the Proposed Action (Section 3.9.4.3). There would be negligible effects to dwarf-bear poppy, Fickeisen plains cactus, Jones cycladenia, Siler pincushion cactus, and Welsh's milkweed within the WTS and STS ROWs under the Natural Gas PFR Alternative from O&M activities based on continued implementation of BMPs. There would be negligible effects to Gierisch mallow and Holmgren milk-vetch, as well as their respective critical habitats, with implementation of conservation measures and BMPs.

Additional disturbance could occur related to connecting a new photovoltaic generation site on tribal land to the existing transmission system and would be evaluated in a subsequent NEPA action and ESA compliance. The exact acres of disturbance are unknown at this time.

3.9.4.6.4 Project Impact Summary – All Project Components

The overall impact of the Tribal PFR Alternative on special status vegetation is expected to be negligible due to the overall effect of the various impact issues.

The Tribal PFR Alternative would result in a 2 to 8 percent power reduction at NGS compared to the Proposed Action, and reductions in coal production at the proposed KMC would result in an approximate

2 to 7 percent reduction in surface disturbance. These reductions would result in lower emissions and deposition of COPECs within the study area and an anticipated slight reduction in the HQs. Based on the NGS Near-field ERA and KMC ERA evaluations, the HQs under the Proposed Action were determined to be less than 1, indicating a negligible risk to special status plants. The ecological risk to vegetation under the Tribal PFR Alternative also would be considered negligible.

O&M activities for the BM&LP Railroad and transmission systems also would result in negligible impacts to special status plants as well as Gierisch mallow and Holmgren milk-vetch critical habitat.

Groundwater pumping at the proposed KMC would result in small baseflow reductions to seeps and springs, representing negligible effects on special status species and habitat.

3.9.4.6.5 Cumulative Impacts

The cumulative impacts of surface disturbance under the Tribal PFR Alternative would be 1 to 5 percent higher than those estimated for the Proposed Action. The surface disturbance contributed by the Tribal PFR Alternative, past and present actions, and foreseeable future actions is estimated to be between 65,408 to 62,853 acres. Reclamation of Tribal PFR Alternative disturbance areas would minimize the project's contribution to cumulative special status species impacts over time.

Cumulative special status species impacts resulting from past and present emissions and deposition in the cumulative effects study area are reflected in the NGS Near-field ERA and KCM ERA baseline COPECs analyses. The ERAs also evaluated future ecological risk from ongoing emissions and deposition. Based on the ERA results for the Proposed Action, the HQs for both baseline and future conditions indicate an ecological risk below 1, indicating that ecological risk to special status plants is not likely under either scenario. Although the Tribal PFR Alternative would result in a slight reduction in emissions deposition, the project's contribution to cumulative ecological risk for special status plants would be considered negligible and would cease following completion of operations in 2044.

Cumulative impacts to special status plants as a result of groundwater pumping-related drawdown in the N-Aquifer under the Tribal PFR Alternative would be the same as discussed in the Proposed Action cumulative impacts sections. As discussed, groundwater modeling indicates that special status plants associated with seeps and springs that have hydraulic connection to the N-Aquifer could experience negligible to minor effects as groundwater levels decline from community pumping in future years. The modeling also indicates that the Proposed Action's contribution to groundwater level declines and associated effects to seeps and springs that support, or may support, these species would be negligible. As the water usage would be the same under both the Tribal PFR Alternative and the Proposed Action, the project's contribution to cumulative groundwater level declines under the Tribal PFR Alternative also would be negligible.

3.9.4.7 No Action

3.9.4.7.1 Navajo Generating Station

3.9.4.7.1.1 Operations and Maintenance, including Surface Disturbance

NGS and some associated facilities (including the BM&LP Railroad) would be decommissioned and reclaimed after 2019 as described in the NGS Operations and Maintenance Plan (**Appendix 1B**) and Chapter 2.0.

Under the No Action Alternative, activities affiliated with NGS would end 25 years before activities under the Proposed Action, and reclamation would take place sooner. This would result in earlier establishment of native vegetative communities that may support special status plants and a temporal decrease in the likelihood of noxious and invasive weeds affecting special status plants.

3.9.4.7.1.2 Emissions and Deposition

The cessation of NGS emissions 25 years earlier than under the Proposed Action would reduce the total NGS-related contribution to COPEC deposition in the NGS Near-field ERA study area. However, the emission/deposition-related impacts to federally listed and other special status species under the No Action Alternative and the Proposed Action would be similar because the Proposed Action ERA analysis indicates HQ numbers less than 1, indicating negligible risk.

3.9.4.7.2 Proposed Kayenta Mine Complex

3.9.4.7.2.1 Operations and Reclamation

Under the No Action Alternative, no mining would occur in the proposed KMC coal resource areas after 2019. However, there are no special status plants that have known occurrences or potential habitat within the proposed KMC and, therefore, no related impacts.

3.9.4.7.2.2 Groundwater Pumping

Federal and other special status plants found within the N-Aquifer study area are listed in **Table 3.9-3**. Under the No Action Alternative, water would continue to be pumped from groundwater wells for dust control and assistance with reclamation activities at the rate of approximately 500 acre-feet per year from 2020 through 2022. Groundwater withdrawals would continue at a rate of approximately 100 acre-feet per year from 2023 through 2032. This minimal groundwater use is anticipated to have negligible effect on special status vegetation resources.

3.9.4.7.3 Transmission Systems and Communication Sites

The NGS transmission system is an established part of the western U.S. transmission grid and supports reliability and delivery of power throughout the region, well beyond the power generated by the NGS. Therefore, under the No Action Alternative it is likely that that one, several, or all of the land owners/managers of the transmission line rights-of-way and communication site leases would renew some portion of the facilities to keep the power grid performing as expected.

In the event it is determined that some or all of the transmission systems and communication site ROWs are not renewed, a lengthy study and permitting process would need to occur before any decommissioning is initiated due to the essential and integral nature of these facilities with the western electric grid. As noted in Section 2.3.3, up to 4,826 acres within and alongside the transmission system corridors could be temporarily disturbed if the entirety of the transmission systems and communication sites were decommissioned and removed.

3.9.4.7.3.1 Operations and Maintenance

Federal and other special status plants found within the WTS and STS are listed in **Table 3.9-4.** Impacts on special status plant species as a result of O&M operations along the WTS and STS and at the communications sites through 2019 would be the same as under the Proposed Action and, therefore, would be negligible.

3.9.4.7.4 No Action Impact Summary – All Project Components

The overall effects of the No Action Alternative on special status plants are expected to be negligible. There would be a potential overall temporal decrease in impacts as operations and reclamation would be completed 25 years earlier than under the Proposed Action.

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Section 3.10

Terrestrial Wildlife Resources

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Acronyms and Abbreviations

1969 Lease	Navajo Project Indenture of Lease
AGFD	Arizona Game and Fish Department
BART	Best Available Retrofit Technology
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BM&LP Railroad	Black Mesa & Lake Powell Railroad
BO	Biological Opinion
CAP	Central Arizona Project
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CO_2	carbon dioxide
COPEC	chemical of potential ecological concern
Co-tenants	Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
Development Fund	Lower Colorado River Basin Development Fund
EIS	Environmental Impact Statement
ERA	Ecological Risk Assessment
ESA	Endangered Species Act of 1973
HHRA	Human Health Risk Assessment
HQ	Hazard quotient
km	kilometer
KMC	Kayenta Mine Complex
kV	kilovolt
kW	kilowatt
MW	megawatt
MOU	Memorandum of Understanding
MBTA	Migratory Bird Treaty Act
N-Aquifer	Navajo Aquifer
NEPA	National Environmental Policy Act of 1969, as amended
NGS	Navajo Generating Station
NGS Participants	U.S. (Reclamation), Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
NHPA	National Historic Preservation Act
NNEPA	Navajo Nation Environmental Protection Agency
NO_2	nitrogen dioxide
NO_X	nitrogen oxide
OSMRE	Office of Surface Mining Reclamation and Enforcement
PFR	Partial Federal Replacement
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less

$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 microns or less
PWCC	Peabody Western Coal Company
Reclamation	U.S. Bureau of Reclamation
ROW	Right-of-way
SO_2	sulfur dioxide
SRP	Salt River Project Agricultural Improvement and Power District
STS	Southern Transmission System
tpy	tons per year
U.S.	United States
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
WTS	Western Transmission System

Contents

3.10 Terrestrial Wildlife Resources 3.10-1
3.10.1 Regulatory Framework 3.10-1
3.10.2 Study Areas..3.10-4
3.10.2.1 Proposed Action and Action Alternatives 3.10-4
3.10.2.2 Cumulative 3.10-5
3.10.2.3 Ecological Risk Assessment – Role in Assessing Baseline Risk and Environmental Consequences 3.10-5
3.10.3 Affected Environment...3.10-7
3.10.3.1 Region-wide Terrestrial Wildlife 3.10-7
3.10.3.2 Navajo Generating Station 3.10-16
3.10.3.3 Proposed Kayenta Mine Complex 3.10-18
3.10.3.4 Transmission Lines and Communication Sites 3.10-19
3.10.4 Environmental Consequences 3.10-20
3.10.4.1 Issues...3.10-20
3.10.4.2 Assumptions and Impact Methodology...3.10-20
3.10.4.3 Proposed Action 3.10-22
3.10.4.4 Natural Gas Partial Federal Replacement Alternative 3.10-32
3.10.4.5 Renewable Partial Federal Replacement Alternative 3.10-36
3.10.4.6 Tribal Partial Federal Replacement Alternative..3.10-38
3.10.4.7 No Action 3.10-41
3.10.5 References 3.10-43

List of Tables

Table 3.10-1 Relevant Statutes, Regulations, and Policies for Wildlife Species 3.10-1
Table 3.10-2 Big Game Species Presence for the Project Components 3.10-8
Table 3.10-3 Birds of Conservation Concern for the Project Components 3.10-12
Table 3.10-4 Impacts to Associated Wildlife Habitat within the Proposed KMC 3.10-26
Table 3.10-5 Emissions Reductions of Selenium, Mercury, and Arsenic Under the Natural Gas PFR Alternative 3.10-33
Table 3.10-6 Emissions Reductions of Selenium, Mercury, and Arsenic Under the Renewable PFR Alternatifve 3.10-36
Table 3.10-7 Emissions Reductions of Selenium, Mercury, and Arsenic Under the Tribal PFR Alternative 3.10-39

3.10 Terrestrial Wildlife Resources

3.10.1 Regulatory Framework

Statutes, regulations, and policies that directly influence wildlife management decisions for the project primarily are implemented by the U.S. Fish and Wildlife Service (USFWS), Navajo Nation, Hopi Tribe, Bureau of Land Management (BLM), U.S. Forest Service, Arizona Game and Fish Department (AGFD), Utah Division of Wildlife Resources, Office of Surface Mining Reclamation and Enforcement (OSMRE), and Nevada Department of Wildlife. Prominent laws, regulations, directives, and agreements relevant to the proposed project are included in **Table 3.10-1**.

Table 3.10-1 Relevant Statutes, Regulations, and Policies for Wildlife Species

Statutes, Regulations, and Policies	Summary
Arizona Revised Statutes Title 17	The State of Arizona's Title 17 – Game and Fish Revised Statutes establish policies and programs for the management, preservation, and harvest of wildlife including aquatic species. Policies directed at managing and conserving aquatic species including invasive species programs and lists, funding/fiscal provisions, rules regarding taking and handling wildlife, and other prohibitions
National Park Service Statutes, Regulations and Policies	National Park Service Organic Act of 1916 (now 54 USC 100101 et. seq.). Glen Canyon National Recreation Area Enabling Legislation (Public Law 92-593). National Park Service Management Policies, Section 4.4 (2006) Glen Canyon National Recreation Area General Management Plan.
BLM Resource Management Plans	The Arizona Strip Field Office, Safford District, Bradshaw-Harquahala, Kanab Field Office, Las Vegas and Pahrump Field Office, Ely District, Phoenix, and the St. George Resource Management Plans specify regulations and goals for management of BLM-administered lands and set restrictions to protect fish and wildlife and the habitats on which they depend.
U.S. Forest Service Land and Resource Management Plans	The Coconino and Tonto National Forest Land and Resource Management Plans identify goals for forest health and constraints on resource uses to meet these goals. Land and Resource Management Plans also identify project restrictions to protect fish and wildlife and management indicator species for each forest.
Navajo Nation Title 17 and 23[1]	The Navajo Nation's Title 17 (Subchapter 21) and 23 classifies terrestrial wildlife species as big game animals, waterfowl, small game animals fur-bearing animals, game birds, raptors, invasive species, and endangered species. These criminal and civil codes also established regulations on unlawful take of these species. This title includes additional species specific regulations such as the Golden and Bald Eagle Protection Regulations and Raptor Electrocution Prevention Regulations.
Navajo Nation Biological Resource Land Use Clearance Policies and Procedures, RCS-44-08[1]	The purpose of the Navajo Nation Biological Resource Land Use Clearance Policies and Procedures is to assist the Navajo Nation government and chapters ensure compliance with federal and Navajo laws which protect, wildlife resources, including plants, and their habitat resulting in an expedited land use clearance process. The Navajo Nation Biological Resource Land Use Clearance Policies and Procedures assists in directing development to areas where impacts to wildlife and/or their habitat will be less significant. Development includes but is not limited to human activities that result in permanent structures, temporary, long-term, or repetitive disturbance to wildlife or habitat as defined by Navajo Nation Code 17 NNC 500 et. Seq.
Utah Code 23-14-1, 23-16, 23-20-3 , and Administrative Rules R657-3, R657-5, R657-6, R657-9, R657-10, R657-11 , R657-19, R657-33, R657-33-3, R657-53, and	Section 23-14-1 of the Utah State Code directs the Utah Division of Wildlife Resources to protect, propagate, manage, conserve, and distribute protected wildlife throughout the state. This statute also authorizes Utah Division of Wildlife Resources to identify and delineate crucial seasonal wildlife habitats. Section 23-20-3 establishes penalties for taking, transporting, selling, or purchasing protected wildlife. Section 23-16 establishes regulations for big game animals.

Table 3.10-1 Relevant Statutes, Regulations, and Policies for Wildlife Species

Statutes, Regulations, and Policies	Summary
R657-54	Utah Administrative Rule R657-3 establishes regulations for collection, transportation and possession of animalsR657-5 and R657-6 establish regulations for taking of big game and upland game. R657-9, R657-10, and R657-11 establish regulations for taking waterfowl, common snipe and coot, taking cougar, and taking furbearers. R657-19 establishes regulations for taking nongame animals. R657-33 established regulations for taking bear. R657-53 establishes rules for amphibian and reptile collection, importation, transportation, and possession.R657-54 establishes regulations for taking wild turkey.
Nevada Revised Statutes Title 45 – Wildlife Chapter 501	Nevada Revised Statutes provide definitions for: big game mammals (501.005), fur-bearing mammals (501.35), game mammals, migratory game birds (501.055), and upland game birds (501.95) and classifications for wildlife (501.110) including wild mammals, wild birds, reptiles, and protected wildlife.
BLM Manual 6500	The BLM Manual 6500 declares that it is the BLM policy to manage habitat with emphasis on ecosystems to ensure self-sustaining populations and a natural abundance and diversity of wildlife, fish, and plant resources on public lands. The Manual further states that to carry out the above policy, the BLM will do inventory, planning, research, monitoring, and maintenance; will communicate, cooperate, and automate; and will hire professional staff.
Migratory Bird Treaty Act (MBTA) (16 United States Code [USC] 703 et seq.)	The MBTA, originally passed in 1918, implements the U.S. commitment to four bilateral treaties [with Canada, Mexico, Japan, and Russia], or conventions, for the protection of a shared migratory bird resource (16 USC 703-712). The MBTA applies only to migratory bird species that are native to the U.S. or its territories. A native migratory bird is defined as one that is present as a result of natural biological or ecological processes. Excluded are species whose presence in the U.S. is solely the result of intentional or unintentional human-assisted introductions. The list of migratory bird species protected by the MBTA appears in 50 Code of Federal Regulations 10.13. The MBTA provides that it is unlawful to pursue, hunt, take, capture, kill, possess, sell, purchase, barter, import, export, or transport any migratory bird, or any part, nest, or egg of any such bird, unless authorized under a permit issued by the Secretary of the Interior. Some regulatory exceptions apply. “Take” is defined in regulations as: “pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to pursue, hunt.” Nongame species that are excluded from protection under the MBTA include the rock pigeon, Eurasian collared-dove, European starling, and house sparrow. For all other native migratory bird species, the MBTA includes, but is not limited to, the following protections: • A total of 1,007 species of migratory birds and their parts, including eggs, feathers, and nests, are protected. • Proof of intent to violate the MBTA is not required for prosecution. • The MBTA has no consultation process such as Section 7 consultation under the Endangered Species Act. The MBTA does not permit incidental or unintentional take, such as that provided by Sections 7 and 10 of the Endangered Species Act.
Bald and Golden Eagle Protection Act (16 USC 668 et seq.)	The Bald and Golden Eagle Protection Act (16 USC 668-668c), enacted in 1940 and amended several times since enactment, prohibits anyone, without a permit issued by the Secretary of the Interior, from “taking” bald eagles, including their parts, nests, or eggs. The Act provides criminal penalties for persons who “take, possess, sell, purchase, barter, offer to sell, purchase or barter, transport, export or import, at any time or any manner, any bald eagle... [or any golden eagle], alive or dead, or any part, nest, or egg thereof.” The Act defines “take” as “pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb.” In addition to immediate impacts, this definition also covers impacts that result from human-induced alterations initiated around a previously used nest site during a time when eagles are not present, if, upon the eagle's return, such alterations agitate or bother an eagle to a degree that

Table 3.10-1 Relevant Statutes, Regulations, and Policies for Wildlife Species

Statutes, Regulations, and Policies	Summary
	interferes with or interrupts normal breeding, feeding, or sheltering habits, and causes injury, death or nest abandonment (USFWS 2016). Eagle breeding activities and nesting locations are afforded legal protection under the act.
Executive Order 13186 (66 Federal Register 3853)	Executive Order 13186 directs federal agencies that take actions that either directly or indirectly effect on migratory birds to develop a Memorandum of Understanding (MOU), and to work with the USFWS, and other federal agencies to promote the conservation of migratory bird populations. So far, nine agencies have completed a MOU with the USFWS under the Executive Order, and several other MOUs are in progress.
BLM MOU WO-230-2010-04	In accordance with Executive Order 13186, this MOU outlines a collaborative approach to promote the conservation of migratory bird populations. The MOU is intended to strengthen migratory bird conservation efforts by identifying and implementing strategies to promote conservation and reduce or eliminate adverse impacts on migratory birds through enhanced collaboration between the BLM and the USFWS, in coordination with State, tribal, and local governments. The MOU also identifies migratory bird conservation as a significant part of the BLM National Environmental Policy Act and planning process. Strategic planning for migratory bird conservation is a key element to the MOU implementations.
U.S. Forest Service Agreement # 08-MU-1113-2400-264	In accordance with Executive Order 13186, this MOU outlines a collaborative approach between the U.S. Forest Service and USFWS to promote the conservation and reduce the take of migratory birds. The Executive Order directs agencies to take certain actions to further comply with the migratory bird conventions, the MBTA, the Bald and Golden Eagle Protection Act, and other pertinent statutes. The purpose of this MOU is to strengthen migratory bird conservation by identifying and implementing strategies that promote conservation and avoid or minimize adverse impacts on migratory birds through enhanced collaboration between the Parties, in coordination with State, Tribal, and local governments. This MOU identifies specific activities where cooperation between Parties will contribute to the conservation of migratory birds and their habitats. These activities are intended to complement and support existing, and facilitate new, collaborative migratory bird conservation partnerships and comprehensive planning efforts for migratory birds.
Avian Power Line Interaction Committee (APLIC) Guidance	APLIC was formed in 1989 to address whooping crane collisions with power lines. Since its inception, the organization has expanded to address a variety of avian/power line interactions including electrocutions, collisions, and nests. APLIC was originally comprised of 10 utilities, the Edison Electric Institute, the USFWS, and the National Audubon Society. The membership now includes over 50 utilities, the Edison Electric Institute, the USFWS, the Electric Power Research Institute, the National Rural Electrical Cooperative Association, and the Rural Utilities Service. APLIC has developed guidance documents identifying causes and minimization methods for avian electrocutions and collisions and released national Avian Protection Plan Guidelines in conjunction with the USFWS in 2005 (APLIC 2016). APLIC also published *Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006* and *Reducing Avian Collisions with Power Lines*: The State of the Art in 2012.
Navajo Nation Department of Fish and Wildlife Raptor Electrocution Prevention Regulations	It is the Navajo Nation Policy to have electrical power companies reduce the likelihood of electrocution of raptors on the Navajo Nation by enforcing raptor-safe power pole design standards for new power line constructions within Raptor Sensitive Areas to protect Golden Eagles, Bald Eagles and Ferruginous Hawks. These regulations apply to projects involving repairs or upgrades to existing power lines within Raptor Sensitive Areas, by requiring raptor-safe power pole designs when poles are replaced, and retrofitting of existing power poles on a case-by-case basis, with techniques to minimize the risk of raptor electrocution. The Department of

Table 3.10-1 Relevant Statutes, Regulations, and Policies for Wildlife Species

Statutes, Regulations, and Policies	Summary
	Fish and Wildlife has identified Raptor Sensitive Areas for these regulations from its knowledge of raptor breeding areas and wintering concentrations. Breeding Area R.S.A.s are depicted as circular areas, centered on nests, that are equal to the average home range size for that species. Breeding Area R.S.A.s are depicted for Golden Eagles (*Aquila chrysaeots*), Bald Eagles (*Haliaeetus leucocephalus*) and Ferruginous Hawks (*Buteo regalis*) because these are native breeding species of the Navajo Nation, susceptible to electrocution, and are listed as “endangered” on the Navajo Endangered Species List. Wintering Concentration R.S.A.s are depicted by the outline of areas known to harbor aggregations of raptors during the winter.

[1] Applies to the Proposed KMC. Pursuant to the Lease Amendment No. 1(or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1), the Nation does not intend to regulate the NGS lease area.

MBTA = Migratory Bird Treaty Act.

MOU = Memorandum of Understanding.

USC = United States Code.

3.10.2 Study Areas

3.10.2.1 Proposed Action and Action Alternatives

As described in Chapter 1.0, there are three main components of the Navajo Generating Station (NGS) and the proposed Kayenta Mine Complex (KMC) Project: the NGS and associated facilities, the proposed KMC, and the transmission systems and communication sites. To facilitate description of the affected environment and analysis of project effects, a total of nine different study areas divided among the three project components have been identified. Refer to Section 3.0 for a more detailed description of these study areas as they pertain to the Ecological Risk Assessments (ERAs). The project components and their associated study areas are listed below and described in detail in subsequent sections:

Navajo Generating Station:

- NGS Near-field Study Area;
- Northeast Gap Region Study Area;
- Southwest Gap Region Study Area;
- San Juan River Study Area; and
- Black Mesa & Lake Powell (BM&LP) Railroad Study Area.

Proposed KMC:

- Proposed KMC Study Area; and
- N-Aquifer Study Area.

Transmission Systems:

- WTS (Western Transmission System) Study Area; and
- STS (Southern Transmission System) Study Area.

3.10.2.2 Cumulative

For terrestrial wildlife resources, the cumulative effects study areas are the same as those described for the Proposed Action and its alternatives. The cumulative effects analysis includes an assessment of total project affects across all study areas plus the effects of other past, present, and reasonably foreseeable actions affecting terrestrial wildlife species within these areas. It should be noted that the actions assessed as part of the cumulative effects analysis may be caused by activities located outside of the study areas listed above (e.g., mercury emissions associated with sources outside of the U.S.). However, to the extent that the effects of these actions combine with project-related effects to terrestrial wildlife within the nine NGS-KMC study areas, they are assessed as cumulative effects.

3.10.2.3 Ecological Risk Assessment – Role in Assessing Baseline Risk and Environmental Consequences

As detailed in Section 3.0, in order to evaluate total future risks associated with emissions from the NGS, the proposed KMC, plus other cumulative sources, it is necessary to consider the level of risk from chemicals currently present in the environment (baseline). Baseline conditions capture naturally occurring chemicals, past emission and deposition from the NGS, and past deposition from other local, regional, and global sources. Four ERAs were performed to evaluate environmental conditions in the vicinity of the NGS and the proposed KMC. The NGS Near-field ERA evaluated the potential risk to terrestrial ecological receptors based on concentrations of future NGS emission chemicals in soil, sediment, and surface water within a defined deposition area around NGS. The NGS Gap Regions ERA evaluated potential risks of future operations of NGS to terrestrial ecological receptors in the riparian corridor of the Colorado River above and below Lake Powell. The NGS San Juan River ERA evaluated potential risk from NGS stack emissions on aquatic oriented wildlife within the San Juan River watershed based on sediment, surface water, and fish tissue concentrations. The KMC ERA evaluated potential risk to special status wildlife species resulting from baseline conditions, proposed future mine operations, NGS emissions, and other cumulative sources of chemicals of potential ecological concern (COPECs) within the proposed KMC. The determination of the study areas are summarized in Section 3.0.2, Ecological and Human Health Risk Assessments, and discussed in detail in **Appendix 3RA**.

Exposure of terrestrial receptors (terrestrial invertebrates, mammals, and birds) was considered for the terrestrial habitat within the study area of each ERA. The exposure pathway evaluated for terrestrial invertebrates included direct contact with COPECs in surface soil. The potential exposure of avian and mammalian receptors to COPECs in surface soil and food items was evaluated by modeling the ingestion of prey items (i.e., terrestrial invertebrates and small mammals), terrestrial plants, inadvertent ingestion of soil, and drinking (surface) water. Data used to characterize baseline conditions for the ERA study areas associated with NGS included a combination of data available in regionally relevant literature and from field sampling.

For each of the ERAs, identification of receptors initially relies on the identification of functional groups or feeding "guilds" that are representative of, or essential to, habitat function. These receptors are representative of entire classes of organisms (i.e., functional groups). Selection criteria for receptors include sensitivity, exposure potential, and expected presence in the study area, ecological relevance, trophic level, feeding habits, and the availability of life history information. Based on the ecological conceptual site models for each ERA study area, both terrestrial receptors (that obtain all food resources from terrestrial sources) and aquatic-oriented receptors (that obtain all or a portion of food resources from aquatic habitats) were evaluated. The representative terrestrial wildlife receptors evaluated included:

- **Terrestrial wildlife receptors:** These receptors were evaluated for exposure to soil, terrestrial food and drinking water and included the terrestrial invertebrate community, and red-tailed hawk (*Buteo jamaicensis*), mourning dove (*Zenaida macroura*), American robin (*Turdus migratorius*), meadow vole (*Microtus pennsylvanicus*), dusky shrew (*Sorex monticolus*),and red fox (*Vulpes vulpes*). Special status terrestrial species evaluated are discussed further in Section 3.11.

- **Aquatic-oriented receptors:** These receptors were evaluated for exposure to sediment, aquatic food, and drinking water and included canvasback duck (*Aythya valisineria*), mallard duck (*Anas platyrhynchos*), muskrat (*Ondatra zibethicus*), little brown bat (*Myotis lucifugus*) and raccoon (*Procyon lotor*). Special status aquatic species evaluated are discussed further in Section 3.13.

Representative species were evaluated for exposure to COPECs identified for each specific risk assessment. For terrestrial wildlife, the hazard quotient (HQ) was based on food web modeling of dietary intake (i.e., exposure estimate based on intake of food and surface water and incidental soil ingestion) and comparison to chemical-specific toxicity values. Information regarding how HQs were calculated and interpretation of the HQ is summarized in Section 3.0.2, Ecological and Human Health Risk Assessments, and is detailed in **Appendix 3RA**. A refined HQ greater than or equal to 1 indicates that there is a potential for adverse effects and other lines of information are used to further evaluate risk.

3.10.2.3.1 NGS Near-field ERA

The deposition area for the Near-field ERA was the 20-kilometer (km) radius from NGS. In the screening level terrestrial food web, terrestrial wildlife receptors (carnivores, insectivores, and herbivores) were assumed to be continually exposed to the maximum baseline soil and surface (drinking) water concentrations. The screening step assumed that receptors feed exclusively within the portion of Lake Powell and the Colorado River within the 20-km NGS Near-field ERA study area. This represents a conservative assumption for those receptors with larger home ranges or those receptors that are known to be only seasonally present within the study area. Also in the screening step, the dietary dose using the food web model is based on maximum COPEC concentrations that are then compared to a no-observed-effect level toxicity value (versus a lowest-observed-effect level) to estimate risk. Use of the no-observed-effect level ensured the highly conservative requirement of the screening step.

3.10.2.3.2 Gap Regions ERA

The study area for the NGS Gap Region ERA includes the Colorado River upstream and downstream of Lake Powell that were not captured in the NGS Near-field or San Juan River ERAs in order to ascertain whether NGS emissions could potentially impact sensitive species directly adjacent to the defined NGS Near-Field Study Area. The determination of the study area and the effects of metals on terrestrial wildlife species are discussed in Section 3.0.2, Ecological and Human Health Risk Assessments. The two Gap Regions that are outside of the 20-km NGS Near-field study area are defined as follows:

- **Southwest Gap Region**: This area includes the lower Colorado River beyond the 20-km NGS Near-field ERA study area below Lees Ferry downstream to the confluence of the Colorado and Little Colorado rivers, approximately 100 km downstream of the Glen Canyon Dam. This reach of river was selected to assure the study area captured humpback chub habitat.
- **Northeast Gap Region**: This area includes the portion of Lake Powell beyond the 20-km NGS Near-field ERA study area and the Colorado River northeast of Lake Powell upstream to the confluence of the Colorado and Green rivers, approximately 274 km upstream of the Glen Canyon Dam.

Based on these study areas, the Gap Regions ERA focused on evaluating impacts to aquatic-oriented receptors only from exposure to key COPECs (i.e., arsenic, mercury, and selenium). The data used to characterize baseline conditions in the Gap Regions was based on available data in the literature for COPECs and existing data developed during the development of the Near-field ERA. Representative terrestrial wildlife species selected for evaluation in the food web model included the bald eagle *(Haliaeetus leucocephalus)*, muskrat, raccoon, little brown bat, mallard duck, and canvasback duck. Special status terrestrial wildlife species analyzed are discussed in Section 3.11.

3.10.2.3.3 San Juan River ERA

The San Juan River ERA study area encompasses the San Juan River from the State Route 371 bridge in Farmington, New Mexico, downstream to the San Juan arm of Lake Powell. The NGS San Juan River ERA evaluated the potential risk to ecological receptors primarily based on data compiled from the literature, input from Reclamation and USFWS, and the results of the NGS Near-field ERA, Gap Region ERA, and the Electric Power Research Institute San Juan River Study (Electric Power Research Institute 2016) to establish baseline conditions. Evaluation of wildlife risk in the San Juan River was focused to evaluation of key COPECs (arsenic, mercury, and selenium).

Similar to the Gap Regions ERA, the San Juan River ERA focused on evaluating potential risk to aquatic-oriented receptors only. Special status terrestrial wildlife species analyzed are discussed in Section 3.11.

3.10.2.3.4 KMC ERA

The KMC ERA was prepared for the proposed KMC to evaluate the potential for adverse effects to ecological receptors from exposure to chemical contaminants dispersed primarily from fugitive dust associated directly and indirectly with mining activities. The proposed KMC ERA Study Area was based on consideration of the Lease Area boundaries (i.e., the areas leased from the Navajo Nation and Hopi Tribes, as shown in **Figure 1-1**), the influence of mining activities, and the presence and locations of special status species (i.e., Mexican Spotted owl and Navajo Sedge).

3.10.3 Affected Environment

3.10.3.1 Region-wide Terrestrial Wildlife

As detailed under Section 3.8, Vegetation, the project is located within the Colorado Plateau physiographic region. Major biotic communities include Great Basin Conifer woodland, a dwarf woodland dominated by pinyon and juniper trees; Great Basin Desert scrub, dominated by a variety of arid land shrubs; Plains and Great Basin grasslands, dominated by a mixture of perennial grasses and low shrubs; Riparian communities dominated by riparian woodlands and shrublands; and Colorado Plateau Mixed Bedrock Canyon and Tableland (**Table 3.8-3**). These biotic communities represent the habitats for terrestrial wildlife species potentially occurring in the region. A variety of wildlife species are associated with these habitats, with greater species diversity occurring in areas exhibiting greater vegetation structure, soil moisture, and open water such as wetlands and riparian areas. Throughout the region, aquatic systems and associated riparian areas play a major role in maintaining biodiversity. Riparian communities provide migratory birds and pollinating insects and bats with vital travel corridors for their migrations between North and South America (AGFD 2012).

Terrestrial wildlife (i.e., big game species, small game species, nongame species, and migratory birds) baseline discussions include descriptions of both resident and migratory species that may occur within the region based on habitat associations. Amphibians and fish are addressed in Section 3.12, Aquatic Biological Resources.

3.10.3.1.1 Big Game Species

Big game species that occur within the region include pronghorn (*Antilocapra americana*), mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), elk (*Cervus canadensis*), desert bighorn sheep (*Ovis canadensis nelson*), javelina (*Tayassu tajacu*), and carnivores including black bear (*Ursus americanus*) and mountain lion (*Puma concolor*) (AGFD 2015a; Nevada Department of Wildlife 2015). Occurrence of these big game species by project component is presented in **Table 3.10-2**.

Table 3.10-2 Big Game Species Presence for the Project Components

Species	NGS [1]	Proposed KMC	N-Aquifer Area	WTS	STS
Pronghorn	X		X	X	X
Mule Deer	X	X	X	X	X
White-tailed Deer		X	X		X
Elk	X	X	X		X
Desert Bighorn Sheep	X			X	
Javelina					X
Black Bear	X			X	X
Mountain Lion	X	X	X	X	X

[1] Includes the NGS Near-field (20-km) study area and the BM&LP Railroad.

N-Aquifer = Navajo Aquifer.

NGS = Navajo Generating Station.

WTS = Western Transmission System.

STS = Southern Transmission System.

Source: AGFD 2015a-h; BLM 2000, 2008a,b; Ecosystem Management, Inc. 2015; OSMRE 2011; Reclamation 2002.

3.10.3.1.1.1 Pronghorn

Pronghorn inhabit grassland, desert shrubland, and sagebrush shrubland in flat to rolling topography and browse on grass, forbs, and shrubs, especially sagebrush, throughout the year. In pronghorn habitat, understory vegetation provides cover for fawning. For example, where they occur, pronghorn typically benefit from habitat with grasses and shrubs greater than 11 inches in height to provide fawns protection from predators during the fawning season; however, this habitat is dependent in large part on weather (e.g., winter snow fall and spring precipitation) (U.S. Forest Service 2014). Fawning typically occurs from May through mid-June. During the winter, pronghorn generally utilize areas of relatively high sagebrush densities and overall low snow accumulations on south- and west-facing slopes. Pronghorn also are considered a Navajo Endangered Species (Mikesic and Roth 2008) and a Management Indicator Species for the Kaibab National Forest. According to the Navajo Nation Department of Fish and Wildlife, occupied habitat is located within the vicinity of Cameron Mountain and Gray Mountain, which are located in close proximity to the southern transmission line system (Smith and Hazelton 2014). Additionally, occupied habitat occurs on the lands managed by the Arizona Strip Field Office crossed by the WTS and crucial year-long habitat is crossed by the WTS on lands managed by the Kanab Field Office in Utah (BLM 2008a). The STS crosses portions of designated Pronghorn Movement Corridors and Fawning Habitat Wildlife Habitat Areas on lands managed by the BLM within the Agua Fria National Monument (BLM 2010).

3.10.3.1.1.2 Mule Deer

The most numerous, widespread, and popular of the big-game animals are deer, with the most abundant in the region being mule deer (AGFD 2015b). Mule deer occupy a variety of habitats from sparse, low deserts to high forested mountains and have a preference for the more rugged country (AGFD 2015b). Although their diet varies somewhat by season, mule deer primarily are browsers, feeding on a wide variety of woody vegetation including shoots, leaves, and twigs of shrubs and trees. Like pronghorn, winter habitat for mule deer occurs in areas of relatively high sagebrush densities and overall low snow accumulation on south- and west-facing slopes. Crucial winter range is crossed by the WTS on lands managed by the BLM Arizona Strip Field Office within the Buckskin Mountains east of Fredonia (BLM 2008b).

3.10.3.1.1.3 White-tailed Deer

White-tailed deer are less common than mule deer in the region but do occur within oak-grasslands, chaparral, and pine forests of central and southeastern Arizona (AGFD 2015c; NatureServe 2015). Within the region, white-tailed deer feed on a variety of vegetation including weeds, shrubs, mast, grass, mistletoe, and cacti fruits in season (AGFD 2015c). This species has been observed within the proposed KMC (Ecosystem Management, Inc. 2015) and has the potential to occur within the N-Aquifer area and along the STS (**Table 3.10-2**).

3.10.3.1.1.4 Elk

Elk may occur within the region in Arizona along all of the project components with the exception of the WTS (**Table 3.10-2**). Elk populations in Arizona are a result of transplanted animals from Yellowstone National Park between 1912 and 1967 (AGFD 2015d). As a result, the Arizona elk population has grown to nearly 35,000 animals. Elk typically are found in forested habitats, specifically fir-aspen and pine-juniper forests. Summer elk range varies from elevations of 7,000 feet in the mixed conifers to 10,000 feet and greater in the spruce fir-sub-alpine belt. Elk populations typically occur within 0.5 mile of water (AGFD 2015d). Elk prefer the summer range, moving to high elevations early and staying until forced down by snow depth (AGFD 2015d). Like other big game species in the region, winter range often is the limiting factor for elk herds as only about 10 percent of their total habitat is winter range. Winter range varies from 5,500 to 6,500 feet in Arizona in the pinyon-juniper zone (AGFD 2015d). Elk feed on a variety of vegetation with food preference including weeds, grasses, sedges, shrubs, willow, and trees in season (AGFD 2015d).

3.10.3.1.1.5 Desert Bighorn Sheep

Desert bighorn sheep occur within the region in Arizona, Utah, and Nevada (AGFD 2015e; Nevada Department of Wildlife 2001; Utah Division of Wildlife Resources 2008).This species is found in desert shrubland and barren/sparsely vegetated habitats and is most common in steep, rocky terrain with abundant grass and browse (Nevada Department of Wildlife 2001; Utah Division of Wildlife Resources 2008). Water sources often are limited in desert bighorn sheep habitat; therefore, this species may occupy habitats near streams, springs, and man-made water sources (i.e., guzzlers) during the summer months (Nevada Department of Wildlife 2001). The diet of the desert bighorn sheep is similar to that of the Rocky Mountain bighorn sheep and primarily consists of grasses, shrubs, and forbs (Nevada Department of Wildlife 2001; Utah Division of Wildlife Resources 2008). Due to the geographic range of the desert bighorn sheep, use of seasonal habitats primarily is determined by water and forage availability rather than weather patterns and snow depth (Utah Division of Wildlife Resources 2008). The desert bighorn sheep also is considered a Navajo Endangered Species (Mikesic and Roth 2008) and BLM sensitive in Nevada. Known occurrence of this species within the region includes the San Juan River in Utah, rare sightings in Marble Canyon along the Colorado River (U.S. Bureau of Reclamation [Reclamation] 2002), and along Kanab Creek and Paria Canyon crossed by the WTS.

3.10.3.1.1.6 Javelina

Javelina, also known as the collared peccary, is considered a big game species that occurs within central and southeastern portions of the region in Arizona. This species occupies a wide variety of habitats including desert, chaparral, and oak-grasslands and are considered opportunistic feeders eating flowers, fruits, nuts, berries, bulbs, and most succulent plants. Prickly pear cactus makes up the major portion of their diet (AGFD 2015f).

3.10.3.1.1.7 Carnivores

Black bear and mountain lions are classified as big game carnivore species in Arizona and Nevada. In Utah, black bear and mountain lions are managed under the furbearer program, which provides certain protections. The distribution for both of these species is dependent on existing and ongoing disturbance and available food sources. Within the region, the black bear is found in most woodland habitats, including pinyon-juniper, oak woodland, coniferous forest, and chaparral (AGFD 2012). Black bears are omnivores, with vegetation (e.g., roots, grass, cactus fruits, and berries) making up the majority of their diet. A small percentage of their diet includes insects, fish, small mammals, reptiles, and amphibians (AGFD 2015g; Utah Division of Wildlife Resources 2010). Mountain lions occupy a variety of habitats within the region. Mountain lions are strongly tied to the distribution of deer, their major prey species (AGFD 2015h).

3.10.3.1.2 Small Game Species

Small game species that occur within the wildlife study area include upland game birds, small mammals, furbearers, and waterfowl. Potential habitat for small game species (except waterfowl) within the region includes all of the vegetative communities present. Potential habitat for waterfowl includes herbaceous wetland, open water, riparian, and woody riparian and wetlands vegetation communities.

3.10.3.1.2.1 Upland Game Birds

Upland game bird species that occur within the region include Merriam's turkey (*Meleagris gallopavo*), band-tailed pigeon (*Patagioenas fasciata*), and mourning dove. Merriam's turkeys are found throughout the western U.S. and primarily within the ponderosa pine forests and oak-brush habitats within the region. They also may be found in riparian and agricultural areas with suitable trees for roosting (AGFD 2015i; Boyle 1998; Utah Division of Wildlife Resources 2011). Band-tailed pigeons occur in Arizona and Utah in forests and mountain shrub habitats; primarily ponderosa pine and oakbrush (AGFD 2015j). The mourning dove is the most widely distributed game bird in North America (George 1988). Mourning doves are capable of traveling long distances to fulfill all of their habitat needs and occupy open prairies, brushlands, and woodlands within the Sonoran Desert (AGFD 2015k).

3.10.3.1.2.2 Small Game Mammals

Based on known ranges and habitat preferences, a variety of small game species, mammalian predators, and furbearers are likely to be present in the region because most of these species are relatively widespread and common. Small game mammals that are likely to occur within the region include desert cottontail (*Sylvilagus audubonii*), black-tailed jackrabbit (*Lepus californicus*), white-tailed jackrabbit (*Lepus townsendii*), and tree squirrels (*Sciurus* spp.) (AGFD 2015l; BLM 2014; Nevada Department of Wildlife 2015).

3.10.3.1.2.3 Furbearers

Furbearers likely to occur within the region include beaver (*Castor canadensis*), muskrat, raccoon, otter (*Lontra canadensis*), ringtail (*Bassariscus astutus*), long-tailed weasel (*Mustela frenata*), short-tailed weasel (*Mustela ermine*), mink (*Neovison vison*), American badger (*Taxidea taxus*), bobcat (*Lynx rufus*), red fox, and coyote (*Canis latrans*) (AGFD 2015m; BLM 2014; Utah Division of Wildlife Resources 2010). Typically, the distribution of furbearers within the region is determined by available food sources (e.g., small rodents, fish, insects, waste grain, and human food waste).

3.10.3.1.2.4 Waterfowl

Waterfowl species are considered game birds, and are protected under the MBTA. The region is located within the Pacific Flyway for migratory birds. Common waterfowl species that may occur within the region include Canada Geese (*Branta canadensis*), mallard, green-winged teal (*Anas crecca*), northern pintail (*Anas acuta*), bufflehead (*Bucephala albeola*), American widgeon (*Anas americana*), common merganser (*Mergus merganser*), common goldeneye (*Bucephala clangula*), and lesser scaup (*Aythya affini*) (AGFD 2015n; Floyd et al. 2007; Stokes and Stokes 1996; Reclamation 2007). These species distributions are limited to the rivers, streams, lakes, reservoirs, ponds, and wetlands found within the region.

3.10.3.1.3 Nongame Species

A diversity of nongame species (e.g., mammals, reptiles, raptors, and passerines) occupy a variety of habitat types within the wildlife analysis area. Common nongame wildlife species discussed include small mammals (e.g., bats, voles, chipmunks, gophers, woodrats, ground squirrels, and mice) and reptiles (e.g., lizards and snakes).

3.10.3.1.4 Migratory Birds

Migratory birds, including passerine and raptors species inhabit all of the vegetation communities/habitat types present throughout the region. The MBTA applies only to migratory bird species that are native to the U.S. or its territories. A native migratory bird is one that is present as a result of natural biological or ecological processes. Excluded are species whose presence in the U.S. is solely the result of intentional or unintentional human-assisted introductions. Nongame species that are excluded from protection under the MBTA include the rock pigeon, Eurasian collared-dove, European starling, and Old World sparrows including the house sparrow. On Navajo Nation lands, these species are protected under Navajo Nation Title 17 (Subchapter 21) and 23, which includes the protection of songbirds, or species of perching birds that feed entirely or chiefly on insects. Further, The Navajo Nation Department of Fish and Wildlife has identified Raptor Sensitive Areas (RSAs) for these regulations from its knowledge of raptor breeding areas and wintering concentrations. Breeding Area RSAs are depicted as circular areas, centered on nests that are equal to the average home range size for that species. Breeding Area RSAs are depicted for Golden Eagles (*Aquila chrysaeots*), Bald Eagles (*Haliaeetus leucocephalus*) and Ferruginous Hawks (*Buteo regalis*) because these are native breeding species of the Navajo Nation, susceptible to electrocution, and are listed as “endangered” on the Navajo Endangered Species List (see Section 3.11.3). Wintering Concentration RSAs are depicted by the outline of areas known to harbor aggregations of raptors during the winter (Navajo Nation Department of Fish and Wildlife 2008).

A wide variety of migratory bird species are found within the region. As documented above for waterfowl, the project lies within the Pacific Flyway for migratory birds. A variety of passerine species occur within the region. Representative species include horned lark (*Eremophila alpestris*), barn swallow (*Hirundo rustica*, black-billed magpie (*Pica hudsonia*), common raven (*Corvus corax*), western meadowlark (*Sturnella neglecta*), American goldfinch (*Carduelis tristis*), and red-winged blackbird (*Agelaius phoeniceus*) (Floyd et al. 2007; Stokes and Stokes 1996). Raptor species that potentially could occur as residents or migrants within the region include eagles (i.e., bald and golden eagles), buteos (i.e., red-tailed hawk, Swainson’s hawk, ferruginous hawk, and rough-legged hawk), falcons (i.e., prairie falcon, peregrine falcon, American kestrel, and merlin), accipiters (i.e., northern goshawk, Cooper’s hawk, sharp-shinned hawk), owls (i.e., barn owl, great horned owl, burrowing owl, long-eared owl, short-eared owl, flammulated owl, western screech owl, and Mexican spotted owl), northern harrier, and osprey (Floyd et al. 2007; Herron et al. 1985; Stokes and Stokes 1996). Migratory bird species, including raptors that are further classified as federally listed, candidate, proposed, state-listed, Navajo Nation endangered, Hopi endangered, BLM sensitive, or U.S. Forest Service sensitive, are identified under Special Status Wildlife Species in Section 3.11.

A list of Birds of Conservation Concern was developed by the USFWS as a result of a 1988 amendment to the Fish and Wildlife Conservation Act. This Act mandated that the USFWS “identify species, subspecies, and populations of all migratory nongame birds that, without additional conservation actions, are likely to become candidates for listing under the Endangered Species Act of 1973.” The goal of the Birds of Conservation Concern list is to prevent or remove the need for additional Endangered Species Act bird listings by implementing proactive management and conservation actions, and to assure that these species would be consulted on in accordance with Executive Order 13186, Responsibilities of Federal Agencies to Protect Migratory Birds (USFWS 2008). These species are presented by project component in **Table 3.10-3**.

Table 3.10-3 Birds of Conservation Concern for the Project Components

Species Common Name (*Scientific Name*)	Potential Occurrence and Season					
	NGS Deposition Area	BM&LP Railroad	Proposed KMC	N-Aquifer Area	WTS	STS
American Bittern (*Botaurus lentiginosus*)					Wintering	
Bald Eagle (*Haliaeetus leucocephalus*)	Wintering	Wintering	Wintering	Wintering	Wintering	Wintering
Bell's Vireo (*Vireo bellii*)					Breeding	Breeding
Bendire's Thrasher (*Toxostoma bendirei*)	Breeding	Breeding	Breeding	Breeding	Breeding	Year-round
Black-chinned Sparrow (*Spizella atrogularis*)					Breeding	Wintering, Breeding
Black-throated Gray Warbler (*Dendroica nigrescens*)						Breeding, Migrating
Brewer's Sparrow (*Spizella breweri*)	Breeding	Breeding	Breeding	Breeding, Migrating	Breeding, Migrating	Breeding, Wintering, Migrating
Burrowing Owl (*Athene cunicularia*)	Breeding	Breeding	Breeding	Breeding	Year-round	Year-round
Canyon Towhee (*Pipilo fuscus*)						Year-round
Cassin's Finch (*Carpodacus cassinii*)	Year-round	Year-round	Year-round	Year-round	Year-round	Year-round
Common Black-hawk (*Buteogallus anthracinus*)						Breeding
Costa's Hummingbird (*Calypte costae*)				Breeding	Breeding	Breeding
Elf Owl (*Micrathene whitneyi*)						Breeding
Ferruginous Hawk (*Buteo regalis*)	Year-round				Year-round	

Table 3.10-3 Birds of Conservation Concern for the Project Components

Species Common Name (*Scientific Name*)	Potential Occurrence and Season					
	NGS Deposition Area	BM&LP Railroad	Proposed KMC	N-Aquifer Area	WTS	STS
Flammulated Owl (*Otus flammeolus*)	Breeding	Breeding	Breeding	Breeding	Breeding	Breeding
Fox Sparrow (*Passerella iliaca*)						Wintering
Gila Woodpecker (*Melanerpes uropygialis*)						Year-round
Gilded Flicker (*Colaptes chrysoides*)					Year-round	Year-round
Golden Eagle (*Aquila chrysaetos*)	Year-round	Year-round	Year-round	Year-round	Year-round	Year-round
Grace's Warbler (*Dendroica graciae*)	Breeding	Breeding	Breeding	Breeding	Breeding	Breeding
Gray Vireo (*Vireo vicinior*)	Breeding	Breeding	Breeding	Breeding	Breeding	Breeding
Green-tailed Towhee (*Pipilo chlorurus*)					Breeding, Wintering	
Juniper Titmouse (*Baeolophus ridgwayi*)	Year-round	Year-round	Year-round	Year-round	Year-round	Year-round
Lark Bunting (*Calamospiza melanocorys*)						Wintering
LeConte's Thrasher (*Toxostoma lecontei*)					Breeding	Breeding
Least Bittern (*Ixobrychus exilis*)						Year-round
Lewis's Woodpecker (*Melanerpes lewis*)	Year-round	Year-round	Year-round	Year-round	Year-round	Year-round
Loggerhead Shrike (*Lanius ludovicianus*)	Year-round	Year-round	Year-round	Year-round	Year-round	Year-round

Table 3.10-3 Birds of Conservation Concern for the Project Components

Species Common Name (*Scientific Name*)	Potential Occurrence and Season					
	NGS Deposition Area	**BM&LP Railroad**	**Proposed KMC**	**N-Aquifer Area**	**WTS**	**STS**
Lucy's Warbler (*Vermivora luciae*)	Breeding	Breeding	Breeding	Breeding	Breeding	Breeding
Mountain Plover (*Charadrius montanus*)						Wintering
Olive Warbler (*Peucedramus taeniatus*)						Breeding
Olive-sided Flycatcher (*Contopus cooperi*)	Breeding	Breeding	Breeding	Breeding	Breeding	Breeding
Peregrine Falcon (*Falco peregrinus*)	Breeding	Breeding	Breeding	Breeding	Year-round	Year-round
Phainopepla (*Phainopepla nitens*)						Breeding
Pinyon Jay (*Gymnorhinus cyanocephalus*)	Year-round	Year-round	Year-round	Year-round	Year-round	Year-round
Prairie Falcon (*Falco mexicanus*)	Year-round	Year-round	Year-round	Year-round	Year-round	Year-round
Red-faced Warbler (*Cardellina rubrifrons*)						Breeding
Sage Thrasher (*Oreoscoptes montanus*)	Breeding				Breeding, Wintering	
Short-eared Owl (*Asio flammeus*)						Wintering
Sonoran Yellow Warbler (*Dendroica petechia sonorana*)					Breeding, Migrating	Breeding
Swainson's Hawk (*Buteo swainsoni*)	Breeding	Breeding	Breeding	Breeding	Breeding	Breeding

Table 3.10-3 Birds of Conservation Concern for the Project Components

Species Common Name (*Scientific Name*)	Potential Occurrence and Season					
	NGS Deposition Area	BM&LP Railroad	Proposed KMC	N-Aquifer Area	WTS	STS
Williamson's Sapsucker (*Sphyrapicus thyroideus*)	Breeding	Breeding	Breeding	Breeding	Breeding	Breeding, Wintering
Willow Flycatcher (*Empidonax traillii*)	Breeding	Breeding	Breeding	Breeding	Breeding	Breeding

Source: USFWS 2015a,b,c,d,e,f.

3.10.3.2 Navajo Generating Station

The study area for the NGS and associated facilities includes the 250-foot corridor for the BM&LP Railroad and four deposition impact areas delineated within the ERAs. The areas were delineated based on an iterative process during the development of the risk assessments and in coordination with the USFWS and cooperating agencies. Coordination for the emission study areas was completed as part of the process for defining sampling location, data review, and methodologies for the ERAs (Ramboll Environ 2016a,b,c,d).

Wildlife habitat types associated with NGS and its associated facilities are detailed under Section 3.8, Vegetation. Important wildlife habitat found within this study area of the project includes associated aquatic habitats of Lake Powell and the Colorado River analyzed for the Gap Regions. There are approximately 80 species of mammals, 35 species of reptiles and amphibians, and 200 species of birds in the Lake Powell area (National Park Service 2005). The NGS Gap Regions were analyzed for potential risks to aquatic and aquatic-oriented wildlife; risks to terrestrial receptors in the Gap Regions are based on results of the NGS Near-field ERA and the potential to be affected by consumption of food obtained from aquatic sources. The Southwest Gap Region includes the lower Colorado River below Lees Ferry downstream to the confluence of the Colorado and Little Colorado rivers. The Northeast Gap Region includes the portion of the Colorado River northeast of Lake Powell upstream to the confluence of the Colorado and Green rivers.

Big game species occurring within the NGS study area include mule deer, desert bighorn sheep, and mountain lion, although uncommon. White-tailed deer have the potential to occur within the Northeast Gap Region along the Colorado River. Common small game species found in the area include dove, turkey, beaver, coyotes, and bobcats (AGFD 2015l; Reclamation 2007). Common waterfowl of Lake Powell and the Colorado River include American widgeon, northern pintail, bufflehead, common goldeneye, common merganser, green-winged teal, lesser scaup, eared grebe (*Podiceps nigricollis*), and mallard (Reclamation 2007). The majority of these are winter residents or spring and fall migrants.

Common nongame species occurring within the NGS study area include small mammals and reptiles. Small mammals found within the NGS study area include ringtail, western spotted skunks (*Spilogale gracilis*) and numerous bat species including the little brown bat, fringed myotis (*Myotis thysanodes*), western pipistrelle (*Pipistrellus hesperus*), Brazilian free-tailed bat (*Tadarida brasiliensis*), and pallid bat (*Antrozous pallidus*) (National Park Service 2016; Reclamation 2007). Other common small mammals include jackrabbit, Ord kangaroo rat (*Dipodomys ordi*), deer mouse (*Peromyscus maniculatus*), pocket mouse (*Chaetodipus* spp. and *Perognathus* spp.), and woodrat (*Neotoma* spp.) (National Park Service 2005). Common reptiles include the Plateau striped whiptail lizard (*Cnemidophorus velox*), gopher snake (*Pituophis catenifer*), Western rattlesnake (*Crotalus viridis*), desert spiny lizard (*Sceloporus magister*), and side-blotched lizard (*Uta stansburiana*) (National Park Service 2005).

The Colorado River corridor provides important habitat for migratory birds (both neotropical songbirds and waterfowl and other wetland dependent species) as well as habitat for resident species. Waterfowl species are described above under nongame species. Migratory songbird species include humming birds, cuckoos, flycatchers, vireos, warblers, tanagers, orioles, and buntings (Reclamation 2007).

Raptors species associated with the NGS study area include sharp-shinned hawk (*Accipiter striatus*), Cooper's hawk (*Accipiter cooperii*), northern harrier (*Circus cyaneus*), red-tailed hawk, Ferruginous Hawk, zone-tailed hawk (*Buteo albonotatus*), common black hawk (*Buteogallus anthracinus),* Harris' hawk *(Parabuteo unicinctus),* bald eagle, golden eagle (*Aquila chrysaetos*), white-tailed kite (*Elanus leucurus*), American kestrel (*Falco sparverius*), peregrine falcon (*Falco peregrinus*), and osprey (*Pandion haliaetus*) (Reclamation 2007). No raptor breeding or wintering RSAs as designated by the Navajo Nation Department of Fish and Wildlife have been identified within the study area on Navajo Nation lands.

Lake Powell and the Colorado River provide important aquatic habitats for migratory bird species in the region. Within the Lake Powell area, most shorebirds are summer residents (Reclamation 2007). Common shorebird species include western sandpiper (*Calidris mauri*), least sandpiper (*Calidris minutilla*), American avocet (*Recurvirostra americana*), long-billed dowitcher (*Limnodromus scolopaceus*), snowy egret (*Egretta thula*), and great blue heron (*Ardrea herodias*) (Reclamation 2007). Along the Colorado River corridor, the aquatic bird community is almost exclusively made up of winter residents (Reclamation 2007). Thirty-four species of wintering waterfowl along with loons, cormorants, grebes, herons, rails, and sandpipers utilize the Colorado River corridor (Reclamation 2007).

Birds of Conservation Concern species identified by the USFWS (2015a,b,c,d,e,f) as occurring within the NGS study area are listed above in **Table 3.10-3**.

The COPECs for evaluation for the project were defined in each of the ERAs (Ramboll Environ 2016a,b,c,d) and were identified based on two previous studies conducted by Electric Power Research Institute (2009, 2011) and input by cooperating agencies regarding project scope in development of the ERAs. These chemicals are associated with coal and coal-fired power plants and included 24 metals (inorganic chemicals), two broad chemical classes of organic compounds (polycyclic aromatic hydrocarbons, or PAHs, and dioxins/furans), and two other organic compounds, benzene and acrolein. This section describes the potential risk to non-special status terrestrial wildlife species from COPEC baseline (current) conditions within the NGS study areas that included ERAs conducted for the NGS Near-field (terrestrial habitats surrounding NGS, and Lake Powell), Colorado River (Gap Regions), and the San Juan River (Ramboll Environ 2016a,b,c). Details regarding the effects of these chemicals on terrestrial wildlife species are provided in the Ecological and Human Health Risk Assessment Summary, **Appendix 3RA**, and summarized in Section 3.0.

3.10.3.2.1 NGS Near-field ERA

Overall, key chemicals are detected at low concentrations and are dispersed throughout the NGS study area with no distinct patterns of occurrence. The complete results are provided in the NGS Near-field Sampling Investigation Report (Ramboll Environ 2016e). Based on evaluation of risk, refined HQs for all of the terrestrial wildlife receptors were less than 1 for all COPECs for baseline conditions within the NGS Near-field study area, indicating that risks to terrestrial wildlife species from baseline conditions are negligible.

3.10.3.2.2 Gap Regions ERA

The study areas for the Gap Regions ERA included the Colorado River upstream and downstream of Lake Powell that were not captured in the NGS Near-field or San Juan River ERAs. Within the Northeast Gap Region, the results of the indicated COPECs (including selenium, mercury, and arsenic) for baseline conditions within the existing environment would pose negligible risk to aquatic-oriented terrestrial wildlife. Within the Southwest Gap Region, HQs exceeded one for bald eagle, canvasback duck, mallard, muskrat, and raccoon exposed to refined methyl mercury concentrations and lowest observed adverse effect level TRVs (HQs ranged from 2-4). HQs exceeded 1 for the muskrat, raccoon and little brown bat exposed to refined concentrations of selenium. HQs exceeded 1 for the muskrat, raccoon and little brown bat exposed to selenium using refined COPEC concentrations and lowest observed adverse effect level TRVs (HQs=2) (**Appendix 3RA**). The results for wildlife were influenced by the results of the Walters et al. (2015) study as data for fish and aquatic invertebrates from that study was used in the Southwest Gap food web model as these organisms are prey items for the representative wildlife species. The high concentrations reported in the Waters et al. (2015) study, which were incorporated and used in this ERA per the recommendation of Reclamation and U.S. Fish and Wildlife Service, significantly influenced the results of the ERA and elevated the perceived risk to representative wildlife species.

3.10.3.2.3 San Juan River ERA

As detailed in the San Juan River ERA (Ramboll Environ 2016c), the risk characterization results showed that the refined HQs for all COPEC/receptor combinations were below 1, indicating that NGS COPECs (selenium, mercury, and arsenic) for baseline conditions within the San Juan River study would pose a negligible risk to non-special status aquatic-oriented wildlife under baseline conditions.

3.10.3.3 Proposed Kayenta Mine Complex

Wildlife habitat within the proposed KMC is dominated by Great Basin conifer woodlands, Big Sagebrush shrublands, reclaimed lands, and lands impacted by human uses/disturbance (**Table 3.8-5**). Aquatic habitats within the proposed KMC are detailed in Section 3.12, Aquatic Biological Resources, and mainly consist of intermittent and ephemeral streams, springs, and artificial sediment ponds within the mine boundary. Important aquatic habitats used by terrestrial wildlife species are found within the N-Aquifer (groundwater) study area (see Section 3.7, Water Resources) and include numerous intermittent streams and washes that support riparian habitats.

According to the 2010 Permit Application Package prepared for the OSMRE, the Surface Mining Control and Reclamation Act of 1977 (30 United States Code 1201-1328), the Surface Mining Control and Reclamation Act amendments, and the Endangered Species Act of 1973 (16 United States Code 1531-1544, 87 Stat. 884), as amended (Ecosystem Management, Inc. 2015), Peabody Western Coal Company (PWCC) is required to monitor wildlife populations during the course of active surface mining activities and after mining activities have been completed. Wildlife-monitoring activities are required to assess impacts of active mining and to demonstrate the suitability of reclamation for wildlife post-mining either before or after bond release.

Big game species within the mine area are present, but uncommon. A 1979-1980 census for game species recorded two observations of mule deer, both north of the PWCC lease area (OSMRE 2011). In 2003, 10 mule deer and numerous pellet groups of mule deer and elk were observed during biological surveys for birds and threatened and endangered species (OSMRE 2011). More recent monitoring has documented the presence of elk, mule deer, and white-tailed deer coinciding with the increased reclaimed lands (OSMRE 2011). Areas of important seasonal use for big game species have not been identified within the proposed KMC. Small game species are similar to those described for the region with documented occurrence of bobcat, red fox, and coyote within the mine area (OSMRE 2011). Upland game birds with potential to occur include dove and turkey (AGFD 2015l). Waterfowl observed in ponds and flooded parts of reclaimed and other areas of the mine included 10 species of ducks, Canada geese, 2 species of grebes, double-crested cormorant (*Phalacrocorax auritus*), white-faced Ibis (*Plegadis chihi*), and American coot (*Fulica americana*) (Ecosystem Management, Inc. 2015).

Deer mice are one of the most common nongame species observed in the mine area, both in native and reclaimed lands. Other common nongame small mammals include ground squirrels (*Ammospermophilus* spp.), brush mice (*Peromyscus boylii*), Ord's kangaroo rat, Stephen's woodrat (*Neotoma stephensi*), black-tailed jackrabbits, desert cottontails, and Colorado chipmunk (*Tamias quadrivittatus*). Gunnison's prairie dogs (*Cynomys gunnisoni*) occur and are being monitored on the mine based on their role as keystone species for other wildlife species (Ecosystem Management, Inc. 2015). Bat studies were conducted in 1999 in reclaimed lands and piñon-juniper within and adjacent to the proposed KMC (OSMRE 2011). Nine bat species were identified including the big brown bat (*Eptesicus fuscus*), long-legged myotis (*Myotis volans*), silver haired bat (*Lasionyctris noctivagans*), pallid bat, fringed myotis, Brazilian free-tailed bat, big free-tailed bat (*Nyctinomops macrotis*), canyon bat (*Parastrellus hesperus*), and an unknown myotis species. Only the first six species were found in the pinyon-juniper habitat, but all nine species were found in the reclaimed lands (OSMRE 2011).

Reptile species, both common and observed, within the proposed KMC include whiptail lizard (*Aspidoscelis* spp.), collared lizard (*Crotaphytus collaris*), sagebrush lizard (*Sceloporus graciosus*), fence lizard (*Sceloporus undulatus*), short-horned lizard (*Phyrnosoma douglassi)*, side-blotched lizard, gopher snake, and western rattlesnake (AGFD 2012; OSMRE 2011).

Bird surveys have recorded 235 bird species in the mine area, more than half of which are known to or potentially nest in the area (OSMRE 2011). Common songbirds recorded during recent wildlife monitoring include the horned lark, western meadowlark, mountain bluebird (*Sialia currucoides*), house finch (*Carpodacus mexicanus*), and multiple species of shrub-nesting sparrows in older reclaimed areas with shrub cover (Ecosystem Management, Inc. 2015). Shorebirds observed within of the mine area include killdeer (*Charadrius vociferus*) and spotted sandpiper (*Actitis macularius*) (Ecosystem Management, Inc. 2015).

Raptor studies in the mine area have recorded raptor species including red-tailed hawks, Cooper's hawks, sharp-shinned hawks, and American kestrels (Ecosystem Management, Inc. 2015; OSMRE 2011). Other less common species that may breed in the mine area include northern goshawk (*Accipiter gentilis*), prairie falcon (*Falco mexicanus*), western screech owl (*Otus kennicottii*), great horned owl (*Bubo virginianus*), northern pygmy owl (*Glaucidium gnoma*), and long-eared owl (*Asio otus*) (OSMRE 2011). Historically, the Mexican spotted owl (*Strix occidentalis lucida*) was observed near the proposed KMC, but annual surveys beginning in 2011 have not documented this species within the vicinity. This species is discussed further in Section 3.11.3.2 due to its special status. Additionally, No raptor breeding or wintering RSAs as designated by the Navajo Nation Department of Fish and Wildlife have been identified within the study area on Navajo Nation lands.

Birds of Conservation Concern species identified by the USFWS (2015b,c) as occurring within the proposed KMC and groundwater drawdown portions of the project are listed in **Table 3.10-3**. Important migratory routes have not been identified within the proposed KMC.

3.10.3.3.1 Baseline Ecological Risk

Based on risk estimates from the KMC ERA, the refined (and average) HQs are less than 1 for terrestrial receptors, indicating negligible risks to terrestrial wildlife (**Appendix 3RA**, Ecological and Human Health Risk Assessments; Ramboll Environ 2016d). Therefore, effects from baseline conditions on terrestrial wildlife species would be negligible (**Appendix 3RA**, Ecological and Human Health Risk Assessments).

3.10.3.4 Transmission Lines and Communication Sites

Big game species within the region of the WTS right-of-way (ROW) include mule deer, pronghorn, desert bighorn sheep, and mountain lion. In addition to the small game species described for the NGS and the proposed KMC project components, the chukar (*Alectoris chukar*), Gambel's quail (*Callipepla gambelii*), and California quail (*Callipepla californica*) are found along the WTS ROW. Chukars are found in central and western Arizona, Utah, and Nevada in dry, rocky terrain with abundant cheatgrass (BLM 2014; Utah Division of Wildlife Resources 2003). Gambel's quail are found along the WTS in Arizona, Utah and Nevada and California quail are found along the WTS in Utah and Nevada (Stokes and Stokes 1996; Utah Division of Wildlife Resources 2011). These two species of quail occupy similar brushy habitats near riparian areas (Stokes and Stokes 1996). Nongame species would be similar to those described for the NGS and proposed KMC project components.

Representative game and nongame terrestrial wildlife species along the STS ROW would be the same as those described for the NGS and proposed KMC project components above, with the addition of javelina and Gambel's quail.

Migratory bird species would be similar to those described for the NGS and proposed KMC project components. A list of Birds of Conservation Concern species potentially occurring along both the WTS and STS ROWs is found in **Table 3.10-3**.

Outside of the NGS Near-field study area, baseline ecological risk has not been evaluated for terrestrial wildlife species as these portions of the study areas occur outside of the area affected by emissions from NGS and the proposed KMC.

3.10.4 Environmental Consequences

3.10.4.1 Issues

The following issues related to terrestrial wildlife species were identified through public and agency scoping. Although there is overlap, issues vary somewhat by project component.

3.10.4.1.1 Navajo Generating Station

Issue 1 – Emissions and Deposition - effects of NGS emissions on terrestrial wildlife species.

Issue 2 – Operations and Maintenance - effects of operations and maintenance of NGS and associated facilities, including the BM&LP Railroad, on terrestrial wildlife species.

3.10.4.1.2 Proposed Kayenta Mine Complex

Issue 1 – Operations and Reclamation - effects of mining operations and reclamation on terrestrial wildlife species.

Issue 2 – Emissions and Deposition - effects of combined emissions from the proposed KMC and NGS on terrestrial wildlife species within the proposed KMC study area.

Issue 3 – Groundwater Pumping - effects of mine-related groundwater pumping from the N-Aquifer on associated stream and spring baseflows that support aquatic, wetland, and/or riparian habitats that may be used by terrestrial wildlife species.

3.10.4.1.3 Transmission Systems and Communication Sites

Issue 1 – Operations and Maintenance - effects of transmission line operations and maintenance on terrestrial wildlife species.

3.10.4.2 Assumptions and Impact Methodology

The following is a list of assumptions made and methodology used to assess impacts of the project as they relate to terrestrial wildlife species. The impacts identified under the separate project components below are based on correspondence with federal and state agencies and, tribal representatives, and based on public scoping comments.

- Terrestrial wildlife species composition and associated habitat within each of the project components was determined by:
  - Consultation and review of existing published data sources from federal and state agencies, as well as PWCC, Navajo Nation, and Hopi Tribe.
  - Identifying the types of terrestrial wildlife habitats (e.g., grasslands, forested lands, riparian areas, etc.) located within the study area using data from the vegetation analysis.
- Species was considered as having the potential to occur within the study area if:
  - Occurrence has been documented for the species; and
  - The current species range exists within the study area and suitable habitat is present.
- There would be no construction disturbance for the NGS, BM&LP Railroad, transmission systems, and communication sites components of the project. The analysis of impacts to terrestrial wildlife species from these components would be limited to operation and maintenance activities.

- Human activity, noise, and surface disturbance associated with decommissioning and reclaiming project facilities including the NGS plant, BM&LP Railroad, and proposed KMC in 2045 may result in short-term impacts on terrestrial wildlife species and their habitats known or with potential to occur in proximity to these facilities. Following completion of these activities, it is assumed that there would be beneficial effects to wildlife.

3.10.4.2.1 Navajo Generating Station

- Utilize the results of the NGS Near-field ERA, Gap Regions ERA, and San Juan River ERA to determine impacts to terrestrial wildlife species resulting from NGS emissions.
- Terrestrial wildlife habitat located within the NGS Near-field ERA, Gap Regions ERA, and the San Juan River ERA, and proposed KMC study areas were analyzed for emission effects on wildlife habitat and representative species. The Gap Regions and San Juan River ERAs apply only to aquatic-oriented terrestrial wildlife.
- Surrogate species identified in the three ERAs are representative of terrestrial wildlife species that occur in the analysis area.
- As detailed in the four ERAs, the risk characterization for future scenarios is conducted in the same way as the risk characterization for baseline conditions.
- As identified in the ERAs, potential exposure routes for wildlife receptors include incidental ingestion of sediment, surface water, or soil, as well as ingestion of food items containing COPECs. The actual amount of exposure by wildlife species as the result of ingestion depends on a number of factors including concentrations of COPECs in food items, size of the receptor, and bioavailability of the COPEC once consumed by the receptor.
- Known or potential occurrence of terrestrial wildlife species were evaluated for the BM&LP Railroad in a qualitative analysis.

3.10.4.2.2 Proposed Kayenta Mine Complex

- Utilize the results of the proposed KMC ERA to determine impacts to terrestrial wildlife species.
- Surrogate species identified in the ERA are representative of terrestrial wildlife species that occur in the analysis area.
- Identify game and nongame terrestrial wildlife species and associated wildlife habitat within project components using published information and internet sites from the Navajo Nation, Hopi Tribe, the state, and PWCC.
- The study area defined for surface water and groundwater impacts are referenced from the water resources section and groundwater model.
- No new surface disturbance is anticipated within the N-Aquifer Study Area outside of the proposed KMC. Only riparian/wetland vegetative communities tied to seeps/springs within this area would have potential to be affected by groundwater drawdown resulting from mine pumping.

3.10.4.2.3 Transmission Systems and Communication Sites

- Known or potential occurrence of terrestrial wildlife species were evaluated for the transmission lines and communication sites in a qualitative analysis.
- The impact analysis for terrestrial wildlife species focuses on O&M activities associated with the transmission line and communication site component of the project. Substations and switchyards affiliated with the WTS and STS occur in or adjacent to the powerline corridor and were included in the analysis.

- Transmission line ROWs and infrastructure have been in place and maintained for 40 years and the proposed vegetation treatments would maintain the existing communities and vegetation types present in the ROWs (i.e., low growing low shrub, herbaceous, and grass species).

3.10.4.3 Proposed Action

3.10.4.3.1 Navajo Generating Station

3.10.4.3.1.1 Emissions and Deposition

The effects of emission of metals on terrestrial wildlife species along with detailed support information are discussed in **Appendix 3RA**, Ecological and Human Health Risk Assessment. The appendix was prepared based on the Near-field, Gap Regions, and San Juan River ERAs (Ramboll Environ 2016a,b,c). The future operations (i.e., 3-Unit Operation and 2-Unit Operation) were analyzed to estimate the potential for adverse impacts to ecological receptors from potential future exposure to chemical contaminants dispersed from stack emissions and other sources at the NGS within the same defined deposition areas as for the baseline evaluation.

<u>NGS Near-field</u>

The determination of the study area and a detailed analysis on the effects of metals on terrestrial wildlife species are discussed in Section 3.0.2, Ecological and Human Health Risk Assessments. The refined HQs for all of the representative terrestrial wildlife receptors were less than 1 for all metals when using refined values for both the 3-Unit Operation and 2-Unit Operation. Therefore, the conclusion of the near-field analysis is that risk to terrestrial wildlife communities as a result of the NGS emissions from the Proposed Action would be negligible.

<u>Gap Regions</u>

The contribution in the Northeast Gap Region from future maximum NGS emissions (3-Unit Operation and 2-Unit Operation) is negligible, resulting in refined risk HQs of less than 1. In the Southwest Gap Region, HQs were well below 1 for each of the representative wildlife receptors included in the ERA and ranged from three to eight orders of magnitude below an HQ of 1 (**Appendix 3RA**). As detailed above in Section 3.10.3.2, baseline conditions are the cause of HQs greater than 1 for total contributions from the Proposed Action plus baseline conditions for methylmercury for each of the six representative wildlife receptors and for selenium among the mammals. Thus, future NGS emissions when combined with baseline conditions may pose risk to the aquatic oriented wildlife species in this region. As discussed in Section 3.10.3.2, baseline mercury levels in the Southwest Gap Region may be overestimated due to the use of questionable baseline mercury data (Ramboll Environ 2016 [3/23/16 Gap Region ERA]). Nonetheless, based on current data, the Proposed Action when combined with potentially degraded baseline conditions may have a minor impact on terrestrial wildlife species.

<u>San Juan River</u>

Based on the results of the refined HQ values all being less than 1 for aquatic-oriented wildlife species under both the 3-Unit Operation and 2-Unit Operation, risks from future project contributions would be negligible to terrestrial wildlife species.

3.10.4.3.1.2 Operations and Maintenance

The Operations and Maintenance Plan (**Appendix 1B**) provides a list of operation, maintenance, and improvement activities that would occur at NGS and associated facilities and along the BM&LP Railroad. Under the Proposed Action, the majority of the operating and support facilities at the plant site would be dismantled and demolished to ground level by December 22, 2045, unless the Navajo Nation continues NGS operations beyond 2044. Details on decommissioning and closure of the NGS and associated facilities are found in **Appendix 1B**.

Potential impacts as a result of proposed NGS operations would include wildlife mortalities that could occur as a result of collisions with trains, the overhead catenary system, and other vehicles used during operation and maintenance activities, increased risk of wildland fires, habitat degradation resulting from surface disturbance, and increased noise and human activity. Impacts to wildlife from operations, maintenance, improvement, and decommissioning activities could include:

- Increased human/wildlife interactions within the ROWs that have the potential to result indirectly in wildlife harassment and accidental mortality.
- An increase in human presence, noise, and traffic levels resulting in an increased potential for wildlife/vehicle collisions.
- Artificial light would likely be used in the case of repairs. Artificial light at night introduced to areas currently without lighting could adversely impact wildlife behaviors including mating, foraging, sleeping, and migratory behaviors (International Dark-sky Association 2008). These behaviors would be determined by the length of nighttime lighting. For example, birds could become disoriented by artificial light, disrupting migration routes and causing additional energy expenditure by staying near light sources. Crepuscular and nocturnal mammals such as raccoons, bats, deer, coyotes, and mice could lose the nighttime ecosystem they depend on for food and protection against predators.
- Wildlife mortality could occur as a consequence of electrocution or collision with powerlines associated with the plant site and the pump powerline to the Lake Pump; and components of the 50-kilovolt (kV) overhead catenary system. However, according to Salt River Project Agricultural Improvement and Power District (personal communication, June 24, 2016) the pump powerline to the Lake Pump has recently been replaced and built to APLIC standards. Components associated with the 50-kV overhead catenary system that is nearing the end of its service life would be replaced in the long term. The replacement catenary design would help avoid and/or mitigate electrical hazards to birds including large raptors and condors (APLIC 2006). Other catenary components and hardware would be replaced on an as-needed basis (**Appendix 1B**).
- Avoidance of otherwise suitable habitat due to increased predation from perching raptors.
- Nest abandonment or loss of eggs or young. These temporary losses would reduce productivity for that breeding season, given the duration of these activities.
- Habitat loss or alteration would result in direct losses of smaller, less mobile wildlife species such as small mammals and reptiles. It also would result in displacement of more mobile species into adjacent habitats during operations, maintenance, improvement, and decommissioning activities.

Impacts from the continued operation of NGS and its associated facilities on terrestrial wildlife within the lease boundary are expected to be minor. Because NGS and its associated facilities have been in operation for approximately 40 years, it is anticipated that most of the terrestrial wildlife species known to occur in the vicinity of the existing NGS and associated facilities, and BM&LP Railroad already are acclimated to the operation of the railroad and the human presence associated with it on some level.

All activities would remain within existing defined boundaries and ROWs and be limited to operation, maintenance, and improvement activities associated with NGS and associated facilities, known disturbance to associated vegetation communities would be limited to the ash disposal site. According to the Operations and Maintenance Plan (**Appendix 1B**), under the 3-Unit Operation, the current footprint of the existing ash disposal area would be expanded by approximately 40 acres (Section 3.8.4.3) within the existing lease area. The existing footprint would not change under the 2-Unit Operation. As initially discussed in Section 3.8.4, revegetation measures are in place to re-establish vegetation cover on the ash landfill (NGS Operations and Maintenance Plan, **Appendix 1B**).

As detailed in Section 2.3.1.2, under the 3-Unit Operation and 2-Unit Operation, the BM&LP Railroad would continue operations; however, the volume of coal delivered could decrease by approximately one-third for the 2-Unit Operation. Thus, instead of three trainloads of 8,000 tons of coal each day, the railroad would operate with a different schedule or capacity to meet NGS fuel demand. Fewer train trips or smaller trains hauling less coal would not substantially change maintenance requirements or potential impacts.

Finally, the following best management practices and protection measures that are part of the NGS-KMC Project (**Appendix 1B**) and correspondence with the Navajo Nation would be implemented to avoid or reduce impacts to terrestrial wildlife species and associated habitats:

- For routine vegetation maintenance (mechanical and hand clearing) and ground-disturbing maintenance activities, workers will watch for nesting birds. If an active nest is found, the vegetation containing the active nest will be avoided until after the nesting season. If the active nest is in vegetation that is causing a safety or system reliably risk, the utility will coordinate with the USFWS and the federal or tribal land manager to determine the appropriate removal procedures and assure compliance with the MBTA and the Navajo Nation Title 17 and 23 regarding songbirds.
- If raptor nests are found on system infrastructure and nest removal or repair work is necessary, the necessary coordination with the USFWS would be conducted to assure compliance with the MBTA, Bald and Golden Eagle Act, and within the Navajo Nation Title 17 and 23 under Golden and Bald Eagle Nest Protection Regulations, as appropriate.
- As transmission and lower voltage power lines are replaced and maintained, installed equipment will meet the most current Avian Power Line Interaction Committee (APLIC) design standards, as well as the Navajo Nation raptor electrocution prevention regulations where applicable to prevent bird electrocutions.
- Speed limits would minimize vehicular collisions with wildlife and decrease fugitive dust emissions.
- Excavation sites would be monitored or covered to avoid trapping wildlife, and routes of escape for wildlife would be maintained. The construction site would be inspected daily for appropriate covering and flagging of excavation sites. Each morning the construction site would be inspected for wildlife trapped in excavation pits.
- While working in riparian areas, workers will reduce the number of trips in and out, use hand crews if possible, minimize time spent working within the riparian area, and/or stage vehicles and materials outside riparian areas, if possible.

3.10.4.3.1.3 Decommissioning and Abandonment

Under the Proposed Action, the majority of the operating and support facilities at the plant site would be dismantled and demolished to ground level by December 22, 2045, unless the Navajo Nation continues NGS operations beyond 2044. Most of the 3,724 acres comprising the plant site and coal ash landfill would be capped, contoured, and revegetated. **Appendix 1B** provides an overview of the decommissioning sequence, including equipment required, and management of residual materials such as fuel oils, sludges, and recyclable materials. Following decommissioning of the plant site, several buildings and other facilities would remain for use by the Navajo Nation and fences around the site and along the railroad would be left in place. Decommissioning of the BM&LP Railroad would involve removal of rails, ties, and overhead power lines. Railroad embankments would be abandoned in place and revegetated.

As required in the 1969 Lease and Lease Amendment (or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1), the land would be restored as closely as possible to original condition where the surface of any leased land has been modified or improved.

It is estimated that herb-dominated habitats such as grasslands would take a minimum of 2 to 5 years to establish adequate ground cover to prevent erosion and provide forage for wildlife species. Woody habitats like sagebrush shrublands would require at least 10 to 25 years for shrubs to recolonize the area.

Although there would be short-term impacts to wildlife associated with increased levels of noise and activity associated with decommissioning activities are expected to re-open and restore wildlife habitat over the long term. Wildlife groups expected to benefit from decommissioning of NGS and associated facilities include small game and non-game species, particularly migratory birds, small mammals, and reptiles that are known or with potential to occur in the area. Because fences would be left in place, big game species such as pronghorn and desert bighorn sheep would not benefit from restoration of the plant site, and the railroad ROW would remain a barrier to the movement of these species.

3.10.4.3.2 Proposed Kayenta Mine Complex

3.10.4.3.2.1 Operations and Reclamation

Potential impacts to wildlife during the proposed KMC operations could include incremental habitat loss and fragmentation, direct mortalities from construction and operation activities, animal displacement and disruption from additional human presence and associated increased noise and light, and the potential for transmission line collisions.

There would be potential for incremental long-term and short-term habitat loss throughout the life-of-mine that would affect big game, small mammals, upland game birds, waterfowl, raptors, songbirds, and reptiles. Impacts to big game species would most likely include the incremental, short-term reduction of potential foraging habitat during the life of the mines. However, because big game species are uncommon within the proposed KMC, individuals temporarily displaced by mining-related activities would be able to relocate to surrounding habitats and would re-inhabit the mining-related disturbed areas following the reestablishment of vegetation. Impacts to small game, migratory bird, and non-game species would be similar to those for big game species and would include the loss of potentially suitable breeding, nesting, and foraging habitat; habitat fragmentation; and displacement of species. Direct impacts also may include nest or burrow abandonment or the loss of eggs or young, resulting in reduced productivity for that breeding season. However, based on the availability of potentially suitable breeding and foraging habitat in the areas adjacent to mining operations, the adverse effects to local populations are anticipated to be low.

Estimated impacts to general vegetation based on the 3-Unit Operation and 2-Unit Operation would be as discussed in Section 3.8 and Section 3.14. For the 3-Unit Operation and 2-Unit Operation, the majority of the impacts would occur within pinyon-juniper woodlands and sagebrush shrublands (**Table 3.10-4**). Loss of these vegetation communities would result in a long-term (greater than 25 years) impact to terrestrial wildlife species associated with these habitats. As discussed in Section 3.14.4.3, most of the reclaimed areas now provide a greater amount of forage vegetation than was available under pre-mine conditions to benefit grazing rights. However, this does not benefit wildlife species associated with the initial loss of woody shrub landcover types such as mule deer, golden eagles, cottontails, and numerous migratory bird and rodent species, as woody vegetation requires long-term time periods (i.e., greater than 25 years) to reestablish. Benefits of reclamation to wildlife species associated with these habitats would only be realized if future reclamation is successful and grazing is managed appropriately. This will require ongoing monitoring and possible reseeding in areas that are less responsive to reclamation. The reclaimed areas will provide habitat for species adapted to habitat edges, early successional environments, and grassland habitats. Species that are highly adaptable could increase in abundance in reclaimed areas. These species include deer, elk, deer mice, Ord’s kangaroo rats, Gunnison’s prairie dogs, Navajo mountain vole, black-tailed jackrabbits, desert cottontails, red foxes, coyotes, some bats, eastern fence izards, prairie falcons, and red-tailed hawks. In the long term, the breeding potential for most raptors could increase as trees develop in portions of the reclamation (OSMRE 2011).

Table 3.10-4 Impacts to Associated Wildlife Habitat within the Proposed KMC

	3-Unit Operation (2044)	2-Unit Operation (2044)
Total Acres Impacted	**5,230**	**4,741**
Landcover Type	**Percent of Impacts within the Proposed KMC Analysis Area**	
Pinyon-juniper Woodlands	20	18
Mixed Salt Desert Scrub	4	<1
Sagebrush Shrublands	4	3.2
Open Water	0	0
Greasewood Shrubland	0	0
Invasive Southwest Riparian Woodland and Shrubland (Tamarisk)	0	0

As detailed in Section 3.8, pit locations proposed for mining would be the same between the 3-Unit Operation and 2-Unit Operation except that under the 2-Unit Operation the rate of mining would proceed more slowly and no mining would occur in the N-10 area. Thus, the 3-Unit Operation would directly impact approximately 489 more acres of pinyon-juniper woodlands, sagebrush shrublands, and mixed salt desert scrub through vegetation removal than the 2-Unit Operation.

Activity at the mine would result in adverse impacts to terrestrial wildlife species from disruptions due to increased human presence, noise, and light. The most common wildlife responses to noise and human presence are avoidance or acclimation. It is not possible to predict the total extent of habitat lost or affected as a result of wildlife avoidance response because the degree of this response would vary from species to species and even between individuals of the same species. However, it is anticipated that most of the terrestrial wildlife species known to occur in the vicinity of existing mines already are acclimated to human presence on some level, or that they have the ability to acclimate, reducing impacts from human avoidance response (Ward 1976). During initial development stages, many species likely would disperse from the area; however, as species become acclimated to human presence and noise, the majority likely would return to reoccupy undisturbed habitats within and surrounding the disturbance areas (Ward 1976).

Increased human/wildlife interactions during the construction and operation phases of mine development would have the potential to indirectly affect wildlife via harassment, poaching, and illegal harvest or accidental mortality. Increased human presence and related increases in traffic levels on mine access routes would increase the potential for wildlife/vehicle collisions, with the greatest potential occurring during peak operations. If construction or ground-clearing activities were to occur during the migratory bird breeding season, direct impacts to breeding birds could include the loss of active nest sites or abandonment of a nest site due to increased human presence and noise in proximity to a nest site. Loss of active nest sites of migratory birds, incubating adults, eggs, or young would be in violation of the MBTA.

Similar to the NGS and associated facilities component of the study area, artificial light would be used at the proposed KMC complex during mining construction and operations. The effects of artificial light would be the same as those listed under for the BM&LP Railroad under NGS and associated facilities in Section 3.10.4.3. To reduce impacts from the use of artificial light, lighting at the proposed KMC would be similar to the lighting currently used at the Kayenta Mine where full-cutoff lighting is used on the dragline booms and at parking lots. Full cutoff lighting directs lighting downward and does not emit any light past 90 degrees of horizontal so there is no upward lighting which would create diffuse lighting effects away from these areas. In addition, full-cutoff lighting requires that at 80 degrees from horizontal the visible light is less than 10 percent of the candlepower of the light source, minimizing the potential for glare related lighting effects away from the area. For safety, in areas where combustible dusts may be present such as coal handling areas different types of lighting are used to reduce the potential for the light to act as an ignition source. Depending on the model, the luminaires are either full-cutoff or semi-cutoff (with 3 percent of the total candlepower emitted at greater than 90° from horizontal). While general lighting provides even, overall illumination for a work area, directional lighting highlights a specific portion of the work area. PWCC uses directional lighting for areas where additional light is needed for a specific area or project.

As a result of the impacts discussed above, impacts to terrestrial wildlife species as a result of mining construction and operations at the proposed KMC complex would be moderate to terrestrial wildlife species.

3.10.4.3.2.2 Emissions and Deposition

The study area for the proposed KMC includes the current Kayenta Mine lease property boundary and proposed expansions. In addition, several locations adjacent but outside of the lease boundary associated with special status species occurrence also are included in the overall study area. A summary of the KMC ERA is provided in **Appendix 3RA**, Ecological and Human Health Risk Assessment and detailed methods and results are provided in the ERA report (Ramboll Environ 2016d). The results consider the contribution from surface disturbance from mining activities associated with coal resource yields of 8.1 million tons per year (tpy) and 5.5 million tpy, which represent the quantity of coal needed to support NGS 3-Unit Operation and 2-Unit Operation, respectively.

The results of the proposed KMC ERA indicated that HQs in the refined evaluation for COPEC/receptor combinations were below 1. As a result, the proposed KMC ERA indicates that impacts from emissions resulting from the operation of NGS and the proposed KMC from 2020 to 2044 from the contribution of the 8.1 million tpy and 5.5 million tpy operations would be negligible to terrestrial wildlife species within the KMC Study Area.

3.10.4.3.2.3 Groundwater Pumping

The habitats associated with naturally occurring groundwater-fed intermittent and ephemeral stream reaches and associated perennial seeps and springs support riparian vegetation (both woody and herbaceous plant species) and wetland areas. Reduction or loss of riparian and wetland habitats supported by these water sources would adversely impact terrestrial wildlife dependent on these sources, resulting in a possible reduction or loss of cover, breeding sites, foraging areas, and changes in both plant and animal community structures.

Due to potential drawdown effects from water pumping within the N-Aquifer, groundwater modeling was conducted for eight geographical groups of springs to determine if project pumping could affect spring outflows. Continued groundwater pumping to support mine operations would result in no measurable decreases in flow in the four U.S. Geological Survey-monitored springs in the N-Aquifer study area (Section 3.7). Moreover, based on groundwater modeling, no change in spring flows would be expected in 95 of 98 non-monitored springs. One spring in each of Spring Groups D (Pasture Canyon/Tuba City/Moenkopi Wash area), F1 (Dennehotso area), and I (Tselani Valley area west of Chinle) would be expected to experience small decreases in flow as a result of mine pumping and associated drawdown of the N-Aquifer (Section 3.7). Surface mining activities such as pit excavations and backfills are predicted to have localized effects on spring flows associated with the shallower Wepo Formation (Section 3.7, Water Resources and Section 3.8). The anticipated flow reductions would be incremental and occur within an over-riding trend of declining springflows due to natural variations including region-wide drought.

Groundwater modeling was conducted to evaluate the effects of mine well pumping on groundwater and connected surface water sources. Details on the groundwater modeling analysis and results are provided in Section 3.7, Water Resources. The modeling analysis investigated potential changes in groundwater contributions to seven streams including Begashibito, Chinle, Dennebito, Jeddito, Moenkopi, and Polacca washes and Laguna Creek. When comparing the simulated stream baseflows for 1956 to those of 2019, modeling results estimated that the maximum decrease in 2019 simulated baseflow would be less than 0.04 cubic feet per second from all previous project groundwater pumping. Over the projected 2020 through 2057 pumping period, the total 3-Unit Operation pumping would be approximately 1,200 acre-feet per year through 2044 and approximately 100 to 500 acre-feet per year through 2057, which is reduced from previous rates, comprising 20 percent of the historic PWCC pumping volume. It is important to note that the pumping analysis extends until 2110 so that the maximum drawdown effect is determined. There is a continued effect beyond the end of pumping. Refer to Section Water Resources in Section 3.7 for additional detail on the groundwater pumping analysis. Based on the future total withdrawal due to proposed project pumping, no measurable change in 2019 stream baseflows are predicted by the model from pumping for either Proposed Action operation (3-Unit Operation and 2-Unit Operation). Therefore, the proposed KMC pumping for operations from 2020-2054 would not result in effects to aquatic habitat with connections to groundwater.

As detailed in Section 3.8.4.3, information concerning how much groundwater levels need to drop before there are effects to seeps/springs and associated riparian habitats is limited. It is expected the changes in water level at the ground surface would have negligible effects to riparian vegetation at seeps/springs because of their small volume. Therefore, the Proposed Action would have negligible effects on the associated aquatic habitat and water sources utilized by terrestrial wildlife species based on drawdown effects within the N-Aquifer because the impact to the resource would be at or below the levels of detection.

3.10.4.3.2.4 Decommissioning and Abandonment

Under the Proposed Action, no mining would occur in the proposed KMC after December 21, 2044. Facilities such as buildings, parking lots, roads, wells, and utilities that are requested to be kept by the tribes would be turned over to them. Other materials having economic value (such as structures and equipment) would be salvaged or recycled. All other materials would be disposed of using approved procedures and in accordance applicable regulations. All sites would be re-contoured to conform to the natural landform, covered with topsoil, and revegetated, using the same post-mining techniques as those proposed for areas disturbed by mining.

The effects of mine decommissioning on terrestrial wildlife species are expected to be beneficial over the long term. Reclamation and re-vegetation of disturbed lands would restore wildlife habitat. The first species to benefit would be those associated with herbaceous habitats. Over time, as shrubs and eventually forest cover returns to the site, other terrestrial wildlife species would benefit as well.

3.10.4.3.3 Transmission Systems and Communication Sites

3.10.4.3.3.1 Operations and Maintenance

Operation and maintenance of the transmission lines and associated facilities would result in no new surface disturbance, but would require periodic aerial and ground inspections, repair and maintenance of infrastructure, maintenance of access routes, and treatment of vegetation within the ROW. The majority of all inspection and maintenance activities would occur along the existing ROWs, serviced by existing roads leading to the regional highway system, and would occur infrequently.

Potential impacts to terrestrial wildlife species would be similar to those discussed above for the operation and maintenance activities occurring at the NGS and associated facilities and along the BM&LP Railroad, with the exception of surface disturbance; a reduction in the amount of acclimation to human presence associated with the operation and maintenance of the ROWs; and the potential for electrocution or collision with electrical components found on the railroad. In comparison between the two transmission systems, due to the low growing and sparsely vegetated land cover, the WTS receives very light human use for maintenance activities (two full length inspections per year) compared to the STS that conducts more routine vegetation maintenance to comply with industry line clearance standards.

Regarding the potential for raptor electrocution or collision, transmission line configurations greater than 69 kV typically do not present a high risk of avian electrocution based on conductor placement and orientation (Avian Power Line Interaction Committee 2006). The STS and WTS are Avian Power Line Interaction Committee compliant or, as replaced or maintained would be compliant with Avian Power Line Interaction Committee design standards to minimize these impacts.

Similar to the determination for operation, maintenance, and improvement activities that would occur at NGS, impacts from the continued operation of the two transmission systems and communication sites on terrestrial wildlife are expected to be minor. To reduce impacts from these activities, line operators would coordinate ongoing periodic line repair and maintenance and vegetation treatments with the appropriate land and wildlife management agencies and incorporate the following best management practices and mitigation measures from the Operations and Maintenance Plan (**Appendix 1B**) and correspondence with the Navajo Nation and BLM as detailed below.

- For routine vegetation maintenance (mechanical and hand clearing) and ground-disturbing maintenance activities, workers will watch for nesting birds. If an active nest is found, the vegetation containing the active nest will be avoided until after the nesting season. If the active nest is in vegetation that is causing a safety or system reliably risk, the utility will coordinate with the USFWS and the federal or tribal land manager to determine the appropriate removal procedures and assure compliance with the MBTA and the Navajo Nation Title 17 and 23 regarding songbirds.
- If raptor nests are found on system infrastructure and nest removal or repair work is necessary, the utility (i.e., Salt River Project Agricultural Improvement and Power District, Arizona Public Service Company, NV Energy) would coordinate with the USFWS, the federal land manager, and/or the tribal land manager to assure compliance with the MBTA, Bald and Golden Eagle Act, and under the Navajo Nation Title 17 and 23 within the Golden and Bald Eagle Nest Protection Regulations, as appropriate.
- Speed limits would minimize vehicular collisions with wildlife and decrease fugitive dust emissions.
- Excavation sites would be monitored or covered to avoid trapping wildlife, and routes of escape for wildlife would be maintained. The construction site would be inspected daily for appropriate covering and flagging of excavation sites. Each morning the construction site would be inspected for wildlife trapped in excavation pits.
- While working in riparian areas, workers will reduce the number of trips in and out, use hand crews if possible, minimize time spent working within the riparian area, and/or stage vehicles and materials outside riparian areas, if possible.
- For the STS, herbicide treatments best management practices would include:
  - Between April 15 and August 15, the spray vehicle will watch for ground nesting birds. If any are seen, the operation will be stopped and the area completed utilizing handheld or backpack sprayers.
  - At any location where the vegetation density is sufficient to provide adequate cover for nest sites, for example dense stands in riparian areas, the area to be treated will be surveyed by the utility (or their contractor) for nests prior to spraying. If nests are found during the survey

or encountered during the course of the application, spraying in the area at and surrounding the nest will cease and be postponed until after August 15 or until the nest is inactive.

- All vehicles will be operated in a safe and prudent manner during daylight hours, maintaining speeds of 15 to 20 miles per hours within the ROW.
- Along the STS on BLM lands, non-emergency maintenance activity should not be conducted in identified pronghorn fawning areas during the fawning season (April 1 and June 1) (BLM 2010).

3.10.4.3.3.2 Decommissioning and Abandonment

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

3.10.4.3.4 Project Impact Summary – All Project Components

The overall effects of the Proposed Action on terrestrial wildlife species would vary from negligible to moderate depending on the activities conducted within each study area.

The overall effects of the Proposed Action's emissions on special status wildlife species would range from negligible to minor when considered in aggregate over the various study areas. With the exception of the aquatic oriented terrestrial receptors within the Southwest Gap Region, NGS and proposed KMC emissions combined with baseline conditions would pose negligible risk to terrestrial wildlife species within the NGS Near-field, Northeast Gap Region, Southwest Gap Region, San Juan River, and proposed KMC study areas as indicated by refined HQs less than 1 for maximum exposure and no adverse effects levels for all species and COPEC combinations. Aquatic oriented terrestrial wildlife in the Southwest Gap Region study area, due to seemingly elevated levels of methylmercury in their diet, are at risk of mercury toxicity under baseline conditions.

Impacts to terrestrial wildlife species resulting from operation and maintenance of NGS and associated facilities and the two transmission systems, as well as the construction and operation of the proposed KMC, would range from minor to moderate depending on species present, the timing of these activities, and the associated habitat disturbed. Impacts to terrestrial wildlife based on operation and maintenance activities associated with human presence, noise, traffic, and artificial lighting is expected to be minor based on wildlife acclimation to these disturbances associated with the historic existence and operation of the NGS and associated facilities, transmission line system, and portions of the proposed KMC. Direct loss of individuals or breeding areas due to vehicle, transmission line, and the overhead catenary system would be considered moderate. Construction activities at the proposed KMC would be considered a moderate impact based on the resulting short-term and long-term habitat loss and fragmentation; and increased human presence, noise, traffic, and artificial lighting in areas of the proposed KMC considered undisturbed. Implementation of general and species-specific best management practices would ensure that impacts to terrestrial wildlife resulting from mine operations and transmission line operation and maintenance activities are avoided and minimized to the extent practicable.

Mine-related groundwater pumping under the 3-Unit Operation is predicted to result in small reductions (0.0004 – 0.0027 cfs) in baseflow in four different washes and at three springs in three different spring groups (0.008 – 0.06 gallons per minute flow reduction) associated with the N-Aquifer. These predicted reductions in spring flows are expected to have negligible effects on riparian habitats with potential to support terrestrial wildlife species.

3.10.4.3.5 Cumulative Impacts

For terrestrial wildlife resources, the Cumulative Effects study areas are the same as those described for the Proposed Action. Refer to Section 3.0 for a detailed description of these study areas. The cumulative effects analysis includes an assessment of total project effects across all study areas plus the effects of other past, present, and reasonably foreseeable actions affecting terrestrial wildlife species within these areas.

3.10.4.3.5.1 Navajo Generating Station

The following discussion is divided into emission and deposition effects followed by other cumulative effects on terrestrial wildlife species for the portions of the overall study area related to each of the study areas.

Other than climate change, no reasonably foreseeable future actions are anticipated at the NGS plant site that would result in cumulative impacts to terrestrial wildlife habitat. All surface disturbances would be confined to the existing NGS plant site, associated facilities, and the existing railroad ROW as a continuation of operations that started in the late 1960s and 1970s. Reclamation measures are in place for the I ash landfill to promote wildlife habitat will recover over the long term. Additionally, no overlapping use of the plant site, associated facilities, and the existing railroad ROW (with the exception of railroad crossings) are permitted. Therefore, no cumulative impacts caused by overlapping on-the-ground activities in the NGS and associated facilities area are foreseen.

The total cumulative impacts from emissions were calculated by considering risks from COPECs currently present in the environment (baseline), as well as COPECs associated with future emissions from the NGS plus other cumulative sources modeled and evaluated from 2020 to 2044. Other cumulative sources addressed impacts from sources other than NGS and proposed KMC including non-U.S. sources added to NGS impacts to estimate the cumulative effects for the ERA study areas. The evaluation is carried through to 2074 to capture the lag period between closure of NGS and movement of COPECs through the watershed and food web.

As described in previous sections, emissions from future operation of NGS under the Proposed Action would result in negligible impacts to terrestrial wildlife. However, when the minute amounts of some trace metals emitted by NGS combine with elevated baseline concentrations and/or other cumulative sources of these metals, they could result in risk to some species.

The NGS Near-field and San Juan ERAs indicate that baseline risk for trace metals, when evaluated together with the Proposed Action and other cumulative sources, would pose negligible risk to terrestrial wildlife species. The cumulative analysis showed that the NGS 3-Unit Operation and 2-Unit Operation combined with baseline conditions and other cumulative emissions resulted in HQs less than 1 for all COPECs, indicating negligible risk to terrestrial wildlife based on cumulative emissions in these study areas.

Within the Gap Regions, results of the ERA indicated that all total cumulative risk HQs using refined concentrations of COPECs were below one for all COPEC/wildlife combinations within the Northeast Gap Region study area. For the Southwest Gap Region study area, total cumulative risk HQs for representative wildlife receptors using refined modeled concentrations of methylmercury and lowest observed adverse effect level TRVs exceeded 1 for each receptor in the food web model with HQs ranging from 2 to 5. In addition, HQs = 2 for muskrat, raccoon, and little brown bat exposed to selenium. As detailed in **Appendix 3RA**, these HQs exceedances are due to baseline contributions to the HQs rather than from future operations. Overall, baseline concentrations, the Proposed Action, and other cumulative sources future contributions from NGS do not pose an unacceptable risk to fish, bird and mammal populations, but risk from other cumulative sources to piscivorous birds cannot be ruled out based on the results of the analysis for the bald eagle discussed in detail in Section 3.11.4.3. Whereas the bald eagle may be at risk of mercury toxicity in the Southwest Gap Region, it should be noted that the contribution of the Proposed Action to that risk is only 0.06 percent.

3.10.4.3.5.2 Proposed Kayenta Mine Complex

The results of the proposed KMC ERA baseline, future emission scenarios, and other cumulative sources indicated that HQs in the refined evaluation for COPEC/receptor combinations were below 1. Therefore, cumulative impacts from emissions and mine activity from 2020-2044 would be negligible to terrestrial wildlife species.

The overall cumulative effect of groundwater pumping in the N-Aquifer area through 2110 would be moderate in Polacca and Chinle washes and Laguna Creek with reductions in annual flow of 32 to 48 percent from 2020 rates (Section 3.7, Water Resources). These reductions result in moderate reductions in the amount of aquatic habitat in these washes where surface water is present and cause reductions in the abundance and diversity of aquatic invertebrates and plants used as food and cover by terrestrial wildlife resources. The cumulative effect is caused by pumping activities other than the proposed project. The project would contribute to a future reduction in base flows of less than 1 percent in these drainages after 2020, based on the results of the groundwater modeling.

3.10.4.3.5.3 Transmission Systems and Communication Sites

The reasonably foreseeable future actions that could result in cumulative impacts to this component of the Proposed Action include the TransWest Express, Southern Nevada Intertie, and Eastern Nevada transmission lines, and the Lake Powell water pipeline and transmission line. The TransWest Express, Southern Nevada Intertie Project, and Eastern Nevada transmission lines may be constructed in an existing West-Wide ROW adjacent to the WTS from the vicinity of Mesquite to the Eldorado Valley south of Las Vegas, Nevada (**Figure 3.0-2**). Segments of the Lake Powell water pipeline and transmission line are proposed to overlap with the WTS utility corridor in Coconino County, Arizona, west of Lake Powell (**Figure 3.0-3**).

The primary potential impacts to wildlife would be attributed to vehicle/wildlife collisions along access roads for project construction and maintenance. These impacts would be reduced by best management practices including controlling vehicle speeds and implementing environmental compliance programs that protect susceptible species. Because of the rural setting of these transmission lines, and lack of fencing or other controls, off-road vehicle disturbance to wildlife would occur throughout the length of these transmission lines resulting in short-term impacts.

3.10.4.4 Natural Gas Partial Federal Replacement Alternative

This discussion is divided into two parts. The first part describes the alternative site and operational characteristics and primary terrestrial wildlife species impacts that have occurred, or would occur. The second part addresses the impacts to terrestrial wildlife species from reducing the power generated at NGS with consequent reductions in coal production at the Kayenta Mine.

Under the Natural Gas Partial Federal Replacement (PFR) Alternative, a selected quantity of power between 100 megawatts (MW) and 250 MW would be contracted for under a long-term power purchase agreement from currently unidentified, existing natural gas generation sources, displacing an equivalent amount of power from the federal share of NGS generation. Because the facility is assumed to currently exist, prior disturbance impacts to terrestrial biological resources are not evaluated. Key assumptions about terrestrial biological resources related to such an existing site are listed below.

- A combined-cycle natural gas power plant would typically be located on a site of approximately 100 acres. No additional surface disturbance would be required over time and the existing plant would have undergone previous National Environmental Policy Act (NEPA) evaluation.
- Potential surface disturbance could occur at scattered locations within the entire site.
- Wildlife habitat would be removed during surface disturbing activities and would not be replaced and revegetated until after facility decommissioning.

- Terrestrial wildlife habitat associated with perennial waterbodies is assumed to be limited within the alternative site due to the arid characteristics of the general region.
- Natural combustion for power generation would not result in COPEC emissions and deposition that would overlap with the coal combustion emissions and deposition from NGS; therefore, there would be no deposition from natural gas combustion to surface water in the study area. The description of emission calculations for the PFR are described in Chapter 2.0 and in Section 3.1, Air Quality.

The focus of this discussion is to distinguish differences in impacts within the replacement alternative operational range to provide a basis for comparison with the Proposed Action.

3.10.4.4.1 Navajo Generating Station

3.10.4.4.1.1 Emissions and Deposition

The Natural Gas PFR Alternative would result in the following reductions in emissions of trace metals for the 100-MW and 250-MW replacements in comparison to the Proposed Action (**Table 3.10-5**).

Table 3.10-5 Emissions Reductions of Selenium, Mercury, and Arsenic Under the Natural Gas PFR Alternative

Trace Metals	Proposed Action Emissions (tpy)	Natural Gas PFR 100-MW Power Reduction (tpy / % change)	Natural Gas PFR 250-MW Power Reduction (tpy / % change)
Selenium	3-Unit 2.237	2.127 / -5%	1.957 / -13%
Selenium	2-Unit 1.491	1.377 / -8%	1.208 / -19%
Mercury (total)	3-Unit 0.117	0.111 / -5%	0.102 / -13%
Mercury (total)	2-Unit 0.078	0.072 / -8%	0.063 / -19%
Arsenic	3-Unit 0.133	0.127 / -5%	0.117 / -13%
Arsenic	2-Unit 0.089	0.083 / -8%	0.073 / -19%

The reduction in power output would result in less coal burned and lower deposition of metals and other COPECs in the portions of the study area analyzed for NGS and associated facilities (i.e., NGS Near-field, Northeast Gap Region of the Colorado River, Southwest Gap Region of the Colorado River, and the San Juan River) when compared to the Proposed Action. The 3-Unit and 2-Unit 100-MW and 250-MW Natural Gas PFR Alternative operations would result in approximately 5 to 19 percent less selenium, arsenic, and mercury than the Proposed Action. As a result of lower deposition of metals, the risk indicator or HQ for terrestrial species would be slightly reduced in each of the study areas. The difference in impacts to terrestrial wildlife species between the Natural Gas PFR Alternative and the Proposed Action would be negligible because the Proposed Action ERA analysis indicates refined HQ numbers less than 1, indicating no risk of effect. Because emissions from NGS are less under the Natural Gas PFR Alternative, COPEC deposition also would have less impact on terrestrial wildlife than the proposed action and, therefore, the impacts are considered negligible.

3.10.4.4.1.2 Operations and Maintenance

Impacts to terrestrial wildlife species as a result of operation, maintenance, and improvement activities occurring at NGS and along the BM&LP Railroad as a result of the Natural Gas PFR would be the same as the Proposed Action. All activities would remain within existing defined boundaries and ROWs and known disturbance to associated vegetation communities would be limited to the ash disposal site. As previously described in Section 3.8.4.4, coal delivery under the Proposed Action would range between 8.1 million tpy and 5.5 million tpy for the 3-Unit Operation or 2-Unit Operation, respectively. Under the Natural Gas PFR Alternative, less coal would be handled and transported on the BM&LP Railroad because less power would be generated. **Table 3.0-6** shows the difference in annual coal production and use. Because coal use is less under the Natural Gas PFR Alternative, O&M activities which occur at NGS, associated facilities, and the BM&LP Railroad may occur less frequently. The reductions in coal use are between 5 and 18 percent annually under the Natural Gas PFR Alternative and because effects from disturbance under the Proposed Action were considered minor, they are considered minor under the Natural Gas PFR Alternative.

According to the Operations and Maintenance Plan (**Appendix 1B**), under the 3-Unit Operation, the current footprint of the existing ash disposal area would be expanded. The existing footprint would not change under the 2-Unit Operation. As initially discussed, revegetation measures are in place to re-establish vegetation cover on the coal ash landfill; successful revegetation prevents soil loss from wind or water erosion at the plant site and coal ash landfill (NGS Operations and Maintenance Plan, **Appendix 1B**).

No new surface disturbance would be required to operate the BM&LP Railroad under both the 3-Unit Operation and 2-Unit Operation. As detailed in Chapter 2.0, under the 3-Unit Operation and 2-Unit Operation, the BM&LP Railroad would continue operations; however, the volume of coal delivered could decrease by approximately one-third for the 2-Unit Operation. Thus, instead of three trainloads of 8,000 tons of coal each day, the railroad would operate with a different schedule or capacity to meet NGS fuel demand. Fewer train trips or smaller trains hauling less coal would not substantially change maintenance requirements or potential impacts from the proposed action and thus the same level of impacts are anticipated.

Under the Natural Gas PFR Alternative, decommissioning and final reclamation of the NGS and BM&LP Railroad would be the same as described for the Proposed Action.

3.10.4.4.2 Proposed Kayenta Mine Complex

3.10.4.4.2.1 Operations and Reclamation

The impacts of mining surface disturbance would be the same as the Proposed Action and considered moderate for terrestrial wildlife species. Mining surface disturbance under this PFR alternative would be proportionally reduced as illustrated in **Table 3.0-7**. It is recognized that actual surface disturbance may not be directly proportional to coal mined because of differences in overburden and coal seam thickness across the coal resource areas.

The impacts of surface coal mining would be moderate because approximately 3,888 to 4,968 acres of new surface disturbance utilized by terrestrial wildlife species are subject to mining activities that include existing intensive surface management programs for soil salvage, soil erosion control, sedimentation control, and revegetation (**Appendix 1B**) that could result in the loss of associated terrestrial wildlife habitat as discussed for the Proposed Action. No permanent ponds that provide habitat for waterfowls and shorebirds would be modified by this alternative. Smaller detention ponds associated with ongoing mining may be closed and filled in as reclamation proceeds. All surface disturbance is subject to a soil stabilization and revegetation adequacy standard prior to release back to the surface owner, the Navajo Nation.

3.10.4.4.2.2 Emissions and Deposition

KMC emissions under the Natural Gas PFR Alternative would be reduced as a result of less coal being burned. There would be a slight reduction in risks to terrestrial wildlife species as indicated by slightly lower HQs. The combination of KMC emissions under this alternative with baseline conditions would represent negligible risks, as HQs would still be less than 1. The impact level would be considered negligible and the effects from this alternative would be the same as described for the Proposed Action.

3.10.4.4.2.3 Groundwater Pumping

Groundwater pumping would be the same as the Proposed Action, with less than 1 percent potential reduction in stream and spring flows. The small anticipated changes in riparian community structure, composition and occupied surface area are not expected to noticeably reduce wildlife habitat values. Therefore, impacts from groundwater pumping would be negligible to terrestrial wildlife species and associated habitat.

3.10.4.4.3 Transmission Systems and Communication Sites

3.10.4.4.3.1 Operations and Maintenance

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

Impacts to terrestrial wildlife species do not differ from the Proposed Action and would be considered minor under the Natural Gas PFR Alternative.

3.10.4.4.4 Project Impact Summary – All Project Components

The overall effects of the Natural Gas PFR Alternative on wildlife species and associated habitats would be similar to the Proposed Action and would vary from negligible to moderate depending on the activities conducted within each study area.

The Natural Gas PFR Alternative would result in 5 to 19 percent power reduction compared to the Proposed Action, which would result in lower emissions and deposition of metals within the study area. As a result of lower deposition of metals, the risk indicator or HQ for terrestrial wildlife species would be slightly reduced in each of the study areas compared to the Proposed Action. NGS and proposed KMC emissions under this alternative by themselves represent a negligible risk on all species.

Impacts to wildlife and associated habitat from surface disturbance and human presence would be moderate due to loss of habitat the potential wildlife mortality and disturbance as indicated under the Proposed Action. The combined new land disturbance at NGS and proposed KMC under the Natural Gas PFR Alternative would range from a high of 4,968 acres to a low of 3,888 acres. This habitat disturbance compares to a Proposed Action range of mining disturbance between a high of 5,429 acres to a low of 5,181 acres, or an overall 5 to 18 percent reduction in new land disturbance for this PFR alternative. The effects from groundwater pumping would be the same as the Proposed Action and considered negligible due to the predicted reductions in spring flows expected to have negligible effects on riparian habitats with potential to support terrestrial wildlife species.

The impacts associated with the operation and maintenance of the transmission systems would be the same as the Proposed Alternative and result in minor effects on terrestrial wildlife.

3.10.4.4.5 Cumulative Impacts

The cumulative impacts of surface disturbance would be 5 to 18 percent less than those estimated for the Proposed Action. However, similar to the Proposed Action, no cumulative impacts caused by overlapping on-the-ground activities in the NGS and associated facilities area are foreseen. In addition, no foreseeable actions would increase the area of disturbance, or the level of human activity. Therefore, cumulative impacts from mine activity from 2020-2044 would be negligible to terrestrial wildlife species.

The combination of NGS and Proposed KMC emissions under the Natural Gas PFR Alternative plus other cumulative deposition sources would result in the same total cumulative emission effects as described for the Proposed Action. The only difference is that the NGS contribution to total cumulative emissions would be slightly less compared to the Proposed Action, as indicated by slightly lower HQs.

However, the project risk and contribution is so small that it does not change the overall effects to terrestrial wildlife species. Risks and effects would negligible as indicated by HQs below 1.

All other cumulative actions in the NGS, proposed KMC, and transmission systems areas that would adversely affect terrestrial wildlife species and their habitat would be the same as discussed in the Proposed Action cumulative impact discussion.

3.10.4.5 Renewable Partial Federal Replacement Alternative

Under the Renewable PFR Alternative, a selected quantity of power between 100 MW and 250 MW would be contracted for under a long-term power purchase agreement from a currently unidentified, existing renewable energy power source, displacing an equivalent amount of power from the federal share of NGS generation. Prior disturbance impacts to terrestrial wildlife resources from the renewable source are not evaluated. Key assumptions about terrestrial wildlife related to such an existing site are listed below.

- A combined-cycle natural gas power plant would typically be located on a site of approximately 100 acres. No additional surface disturbance would be required over time and the existing plant would have undergone previous NEPA evaluation.
- Wildlife habitat was likely removed from the site and would not be revegetated until after facility decommissioning.
- Combustion and emissions for power generation from this alternative would not result in COPEC emissions and deposition that would overlap with the coal combustion emissions and deposition from NGS; therefore, there would be no deposition from natural gas combustion to surface water in the study area. The description of emission calculations for the PFR is described in Chapter 2.0 and in Section 3.1, Air Quality.

3.10.4.5.1 Navajo Generating Station

3.10.4.5.1.1 Emissions and Deposition

The Renewable PFR Alternative would result in less coal burned and lower deposition of metals and other chemicals of concern in the portions of the study area analyzed for NGS and associated facilities (i.e., NGS Near-field, Gap Regions of the Colorado River, and the San Juan River) when compared to the Proposed Action (**Table 3.10-6**).

Table 3.10-6 Emissions Reductions of Selenium, Mercury, and Arsenic Under the Renewable PFR Alternative

Trace Metals	Proposed Action Emissions (tpy)		Renewable PFR 100-MW Power Reduction (tpy / % change)	Renewable PFR 250-MW Power Reduction (tpy / % change)
Selenium	3-Unit	2.237	2.174 / -3%	2.075 / -7%
Selenium	2-Unit	1.491	1.424 / 4%	1.325 / -11%
Mercury (total)	3-Unit	0.117	0.114 / -3%	0.108 / -7%
Mercury (total)	2-Unit	0.078	0.075 / 4%	0.069 / -11%
Arsenic	3-Unit	0.133	0.130 / -3%	0.124 / -7%
Arsenic	2-Unit	0.089	0.086 / -4%	0.080 / -11%

As a result of lower deposition of metals, the risk indicator or HQ for terrestrial wildlife species would be slightly reduced in each of the study areas compared to the Proposed Action. Although there is a slight reduction in project risks from mercury and selenium, the combination of Renewable PFR Alternative with baseline conditions would represent the same risks and effects as discussed for the Proposed Action and the Natural Gas PFR Alternative.

3.10.4.5.1.2 Operations and Maintenance

Impacts to terrestrial wildlife species as a result of operation, maintenance, and improvement activities occurring at NGS and associated facilities, and along the BM&LP Railroad as a result of the Renewable PFR would be the same or less as the Proposed Action. All activities would remain within existing defined boundaries and ROWs and known disturbance to associated vegetation communities would be limited to the ash disposal site. Because coal production is less under the Renewable PFR Alternative, O&M activities which occur at NGS, associated facilities, and the BM&LP Railroad may occur less frequently. The reductions in coal production are between 2 percent and 11 percent annually under the Renewable PFR Alternative and because effects from disturbance under the Proposed Action were considered minor, they are considered minor under the Renewable PFR Alternative.

3.10.4.5.2 Proposed Kayenta Mine Complex

3.10.4.5.2.1 Operations and Maintenance

Surface disturbance caused by mining at the proposed KMC under the Renewable PFR Alternative would be proportionally reduced from 3 to 10 percent as compared to the Proposed Action, and by 5 to 18 percent as compared to the Natural Gas PFR Alternative (**Table 3.0-7**). Implementation of the Natural Gas PFR Alternative would not require any changes in the operation and maintenance of the WTS, STS, and the associated communication sites. The impacts of surface coal mining to terrestrial wildlife species under the Renewable PFR Alternative would be similar to the Proposed Action and the Natural Gas PFR Alternative; and be considered as moderate for terrestrial wildlife species. As discussed in Section 3.8.4.3, the Proposed Action would remove approximately 4,741 to 5,230 acres (12.5 and 13.8 percent) of native vegetation under the 3-Unit Operation and 2-Unit Operation. As displayed in **Table 3.0-7**, approximately 4,267 to 5,072 acres of new surface disturbance would occur under the 100-MW and 250-MW reductions under the Renewable PFR Alternative.

Under the Renewable PFR Alternative, decommissioning and final reclamation of the NGS and BM&LP Railroad would be the same as described for the Proposed Action.

3.10.4.5.2.2 Emissions and Deposition

The effects of the Renewable PFR Alternative from emissions on terrestrial wildlife would be similar to those described for the Proposed Action and the Natural Gas PFR Alternative. There would be negligible effects on associated aquatic resources utilized by terrestrial wildlife species from KMC emissions in relation to the 8.1 million tpy (3-Unit) and 5.5 million tpy (2-Unit) coal production operations.

3.10.4.5.2.3 Groundwater Pumping

The effects of the Renewable PFR Alternative from groundwater pumping on terrestrial wildlife would be the same as described for the Proposed Action and the Natural Gas PFR Alternative. There would be negligible effects on associated aquatic resources utilized by terrestrial wildlife species from groundwater pumping in relation to the 8.1 million tpy (3-Unit) and 5.5 million tpy (2-Unit) coal production operations.

3.10.4.5.3 Transmission Systems and Communication Sites

3.10.4.5.3.1 Operations and Maintenance

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

Impacts to terrestrial wildlife species do not differ from the Proposed Action and would be considered minor under Renewable PFR Alternative.

3.10.4.5.4 Project Impact Summary – All Project Components

The overall effects of the Renewable PFR Alternative on wildlife species and associated habitats would be similar to the Proposed Action and would vary from negligible to moderate depending on the activities conducted within each study area.

The Renewable PFR Alternative would result in lower emissions and deposition of metals within the study area compared to the Proposed Action. As a result of lower deposition of metals, the risk indicator or HQ for terrestrial wildlife species would be slightly reduced in each of the study areas compared to the Proposed Action. NGS emissions under this alternative by themselves represent a negligible risk on all species, as indicated by refined HQ values of less than one. The effects of the Renewable PFR Alternative in combination with baseline conditions would be the same as described for the Proposed Action and the Natural Gas PFR Alternative. In addition, impacts from surface disturbing activities, human disturbance, and groundwater pumping would be the same as the Proposed Action and the Natural Gas PFR Alternative.

3.10.4.5.5 Cumulative Impacts

The cumulative impacts of surface disturbance would be 3 to 10 percent less than those estimated for the Proposed Action. However, similar to the Proposed Action, no cumulative impacts caused by overlapping on-the-ground activities in the NGS and associated facilities area are foreseen. In addition, no foreseeable actions would increase the area of disturbance, or the level of human activity. Therefore, cumulative impacts from mine activity from 2020-2044 would be negligible to terrestrial wildlife species. The combination of NGS and Proposed KMC emissions under the Renewable PFR Alternative plus other cumulative deposition sources would result in the same total cumulative emission effects as described for the Proposed Action. The only difference is that the NGS contribution to total cumulative emissions would be slightly less compared to the Proposed Action, as indicated by slightly lower HQs. However, the project risk and contribution is so small that it does not change the overall effects to terrestrial wildlife species.

All other cumulative impacts for the Renewable PFR Alternative would be the same as the Proposed Action and the Natural Gas PFR Alternative.

3.10.4.6 Tribal Partial Federal Replacement Alternative

Under the Tribal PFR Alternative, between 100 MW and 250 MW of power generation from the NGS would be replaced by power supplied by a new photovoltaic generation facility on tribal land, displacing an equivalent amount of power from the federal share of NGS generation. The construction of a new photovoltaic generation site on tribal land would result in between 1,200 and 3,000 acres of new surface disturbance. The Tribal PFR facility would be analyzed in a separate NEPA process once a facility location is identified. Key assumptions about terrestrial wildlife related to the construction of a new photovoltaic facility are detailed below.

- The construction of a new photovoltaic generation site on tribal land would require the commitment of land and would result in new surface disturbance at a location that would be evaluated in a subsequent NEPA action in which specific impacts to terrestrial wildlife will be discussed.
- Natural gas combined cycle firming power would not result in COPEC emissions deposition that would overlap with the associated with coal combustion emissions and deposition from NGS under the Proposed Action. The emissions caused from construction of the solar facility (fugitive dust and vehicles) could be located in the NGS study area but would be very localized and temporary, and therefore, considered to have no effect on terrestrial wildlife resources and not

carried forward in the analysis. This description of emission calculations for the PFR are described in Chapter 2.0 and in Section 3.1, Air Quality.

- The duration of construction of a photovoltaic site would take between 1.5 and three years.
- The land area required for a photovoltaic site would be between approximately 1,200 and 3,000 acres.

3.10.4.6.1 Navajo Generating Station

3.10.4.6.1.1 Emissions and Deposition

Selenium, arsenic and mercury for PFR NGS stack emissions would be reduced relative to the Proposed Action (**Table 3.10-7**).

Table 3.10-7 Emissions Reductions of Selenium, Mercury, and Arsenic Under the Tribal PFR Alternative

Trace Metals	Proposed Action (tpy)	Tribal PFR 100-MW Power Reduction (tpy / % change)	Tribal PFR 250-MW Power Reduction (tpy / % change)
Selenium	3-Unit 2.237	2.193 / -2%	2.123 / -5%
Selenium	2-Unit 1.491	1.443 / -3%	1.373 / -8%
Mercury (total)	3-Unit 0.117	0.115 / -2%	0.111 / -5%
Mercury (total)	2-Unit 0.078	0.076 / -3%	0.072 / -8%
Arsenic	3-Unit 0.133	0.121 / 9%	0.127 / -5%
Arsenic	2-Unit 0.089	0.087 / -3%	0.083 / -8%

As a result of lower deposition of metals, the risk indicator or HQ for terrestrial wildlife species would be slightly reduced in each of the study areas compared to the Proposed Action. Although there is a slight reduction in project risks from arsenic, mercury and selenium, the combination of Tribal PFR Alternative with baseline conditions would represent the same risks and effects as discussed for the Proposed Action and the Natural Gas and Renewable PFR alternatives.

3.10.4.6.1.2 Operations and Maintenance

Impacts to terrestrial wildlife species as a result of operation, maintenance, and improvement activities occurring at NGS and along the BM&LP Railroad as a result of the Tribal PFR would be nearly the same as the Proposed Action and both the Natural Gas and Renewable PFR alternatives. All activities would remain within existing defined boundaries and ROWs and known disturbance to associated vegetation communities would be limited to the ash disposal site. Because coal production is less under the Renewable PFR Alternative, O&M activities which occur at NGS, associated facilities, and the BM&LP Railroad may occur less frequently. The reductions in coal production are between 2 and 7 percent annually under the Tribal PFR Alternative and because effects from disturbance under the Proposed Action were considered minor, they are considered minor under the Tribal PFR Alternative.

Under the Tribal PFR Alternative, decommissioning and final reclamation of the NGS and BM&LP Railroad would be the same as described for the Proposed Action.

3.10.4.6.2 Proposed Kayenta Mine Complex

3.10.4.6.2.1 Operations and Maintenance

Surface disturbance caused by mining at the proposed KMC under the Tribal PFR Alternative would be proportionally reduced from 2 to 7 percent, compared to 5 to 18 percent under the Natural Gas PFR

Alternative and 3 to 10 percent under the Renewable PFR Alternative (**Table 3.0-7**). The impacts of surface coal mining to terrestrial wildlife species under the Tribal PFR Alternative would be similar to the Proposed Action and both the Natural Gas and Renewable PFR alternatives; and be considered as a moderate impact to terrestrial wildlife species. As discussed in Section 3.8.4.4, the Proposed Action would remove approximately 4,741 to 5,230 acres of native vegetation under the 3-Unit Operation and 2-Unit Operation. This is between 12.5 percent and 13.8 percent of native vegetation removed, having a moderate impact on native vegetation. These areas would eventually be reclaimed with a grassland community. As displayed in **Table 3.0-7**, approximately 4,409 to 5,124 acres of new surface disturbance would occur under the 100-MW and 250-MW reductions under the Tribal PFR Alternative.

3.10.4.6.2.2 Emissions and Deposition

The effects of the Tribal PFR Alternative from emissions on terrestrial wildlife would be similar to those described for the Proposed Action and both the Natural Gas and Renewable PFR alternatives. There would be negligible effects on associated aquatic resources utilized by terrestrial wildlife species from KMC emissions in relation to the 8.1 million tpy (3-Unit) and 5.5 million tpy (2-Unit) coal production operations.

3.10.4.6.2.3 Groundwater Pumping

The effects of the Tribal PFR Alternative from groundwater pumping on terrestrial wildlife would be similar to those described for the Proposed Action and both the Natural Gas and Renewable PFR alternatives. There would be negligible effects on associated aquatic resources utilized by terrestrial wildlife species from groundwater pumping in relation to the 8.1 million tpy (3-Unit) and 5.5 million tpy (2-Unit) coal production operations.

3.10.4.6.3 Transmission Systems and Communication Sites

3.10.4.6.3.1 Operations and Maintenance

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

Impacts to terrestrial wildlife species do not differ from the Proposed Action and would be considered minor under the Tribal PFR Alternative. Additional disturbance could occur to an unknown number of acres related to connecting a new photovoltaic generation site on tribal land to the existing transmission system and would be evaluated in a subsequent NEPA action.

3.10.4.6.4 Project Impact Summary – All Project Components

In summary, the Tribal PFR Alternative would result in lower emissions and deposition of metals within the study area compared to the Proposed Action. As a result of lower deposition of metals, the risk indicator or HQ for terrestrial wildlife species would be slightly reduced in each of the study areas compared to the Proposed Action. NGS emissions under this alternative by themselves represent a negligible risk on all species, as indicated by refined HQ values of less than one. The effects of the Tribal PFR Alternative in combination with baseline conditions would be the same as described for the Proposed Action and both the Natural Gas and Renewable PFR alternatives.

Impacts from surface disturbing activities, human disturbance, and groundwater pumping would be the same as the Proposed Action and both the Natural Gas and Renewable PFR alternatives. In terms of the analysis for the proposed KMC, there would be 2 to 7 percent less surface disturbance than the Proposed Action, which is still a moderate effect on terrestrial wildlife species. Effects from groundwater pumping for the KMC would be negligible.

The operation and maintenance of the transmission systems would result in negligible effects to general vegetation due to vegetation maintenance and other O&M activities. By following best management practices, effects on general vegetation will be minimized.

3.10.4.6.5 Cumulative Impacts

The impacts of the construction of a new photovoltaic generation site on tribal land would require additional commitments of the land, and would result in new surface disturbance and impacts to terrestrial wildlife species. However, similar to the Proposed Action, no cumulative impacts caused by overlapping on-the-ground activities in the NGS and associated facilities area are foreseen. In addition, no foreseeable actions would increase the area of disturbance, or the level of human activity. Therefore, cumulative impacts from mine activity from 2020-2044 would be negligible to terrestrial wildlife species. The combination of NGS and Proposed KMC emissions under the Tribal PFR Alternative plus other cumulative deposition sources would result in the same total cumulative emission effects as described for the Proposed Action. The only difference is that the NGS contribution to total cumulative emissions would be slightly less compared to the Proposed Action, as indicated by slightly lower HQs. However, the project risk and contribution is so small that it does not change the overall effects to terrestrial wildlife species.

All other cumulative impacts from the Tribal PFR Alternative would be the same as the Proposed Action and both the Natural Gas and Renewable PFR alternatives.

3.10.4.7 No Action

3.10.4.7.1 Navajo Generating Station

If continued operation of NGS and the BM&LP Railroad is not approved, the power plant would be decommissioned, and components of the plant demolished and placed in on-site or off-site landfills. As described under Section 3.8.4.7, there is low risk that additional vegetation would be removed because disturbed areas would not be enlarged during decommissioning and reclamation. However, due to the earthwork necessary for decommissioning activities like grading and revegetation, some vegetation would likely be disturbed in the existing ROW and lease area footprint. These areas would be revegetated with native vegetation once the decommissioning activities are completed. Similar to the Proposed Action, the effects of the No Action Alternative would be considered minor due to the expected surface disturbance and human disturbance.

Emissions under the No Action Alternative would be represented by the existing conditions plus the cumulative source impacts over the same time period (through 2074), but with the exclusion of current NGS emissions. The elimination of current NGS emissions would subtract a very small emission level from existing conditions. As a result, the risk indicator or HQ for terrestrial wildlife species would be slightly reduced in each of the study areas compared to the Proposed Action. Although there is a slight reduction in project risks from arsenic, mercury and selenium, the baseline conditions would represent the same risks and effects as discussed for the Proposed Action and PFR alternatives.

3.10.4.7.2 Proposed Kayenta Mine Complex

No mining would occur in the proposed KMC coal resource areas after 2019. The predicted removal of natural vegetation (up to 5,230 acres) by the Proposed Action would not occur. Reclamation would consist of regrading, application of growth media (suitable overburden and soil), and reseeding disturbed areas. There is low risk that additional wildlife habitat would be removed because disturbed areas would not be enlarged during decommissioning and mine reclamation. Additional mitigation measures and best management practices would be applied to mine areas to benefit wildlife species during reclamation of the site. Therefore, there would be short-term minor impacts to terrestrial wildlife species from reclamation activities, similar to those described for the Proposed Action. However, terrestrial wildlife species would receive long-term benefits from the lack of mining and the return of native habitats.

The effect of emissions from the No Action Alternative would be the same as baseline conditions combined with other cumulative sources analyzed in the proposed KMC ERA. Emissions under the No Action Alternative would subtract the very small contribution from the proposed KMC facilities. Because the elimination of emission effects from the proposed KMC facilities would be very small, the resulting metal concentrations in waterbodies would be nearly the same as baseline conditions in combination with other cumulative sources characterized in the proposed KMC ERA (Ramboll Environ 2016d).

The actions required for decommissioning of NGS and associated facilities under the No Action alternative would be the same as those described under the Proposed Action.

The No Action Alternative includes pumping from community wells and windmills, pumping from leasehold wells for reclamation activities and water needs of local residents and the Many Mules project, and residual effects from past mine pumping. Pumping under the No Action Alternative would result in flow reductions of approximately 18 to 47 percent in Polacca, Chinle, and Begashibito washes and Laguna Creek, primarily caused by local community pumping. No future mine dewatering from the proposed KMC facilities would occur under the No Action Alternative resulting in negligible impacts to water resources.

3.10.4.7.3 Transmission Systems and Communication Sites

The NGS transmission system is an established part of the western U.S. transmission grid and supports reliability and delivery of power throughout the region, well beyond the power generated by the NGS. Therefore, under the No Action Alternative it is likely that that one, several, or all of the land owners/managers of the transmission line rights-of-way and communication site leases would renew some portion of the facilities to keep the power grid performing as expected.

In the event it is determined that some or all of the transmission systems and communication site ROWs are not renewed, a lengthy study and permitting process would need to occur before any decommissioning is initiated due to the essential and integral nature of these facilities with the western electric grid. As noted in Section 2.3.3, up to 4,826 acres within and alongside the transmission system corridors could be temporarily disturbed if the entirety of the transmission systems and communication sites were decommissioned and removed.

3.10.4.7.4 No Action Impact Summary – All Project Components

In summary, the No Action Alternative would result in emissions resulting from existing baseline conditions plus the cumulative source impacts over the same time period (through 2074), but with the exclusion of current NGS emissions. The elimination of current NGS emissions would subtract a very small emission level from existing conditions. Therefore, the effects of No Action emissions on terrestrial wildlife communities in any of the ERA study areas would be the same as the Proposed Action because of the current baseline conditions. Because the elimination of emission effects from the proposed KMC facilities would be very small, the resulting metal concentrations would be nearly the same as baseline conditions in combination with other cumulative sources characterized in the proposed KMC ERA.

The No Action Alternative would result in minor impacts to terrestrial wildlife resources as a result of decommissioning and reclamation of the existing project facilities. Shorter-term effects would occur during restoration leading to longer-term benefits to resources as terrestrial wildlife habitats are established.

Pumping considered under the No Action Alternative would result in flow reductions of approximately 18 to 47 percent in Polacca, Chinle, and Begashibito washes and Laguna Creek (mostly caused by local community pumping), which would moderately reduce aquatic habitat and invertebrate and plant abundance when water is present. No future mine dewatering from the proposed KMC facilities would occur under the No Action Alternative. The impacts of No Action on terrestrial wildlife species and associated habitat that are near or crossed by the transmission line ROWs generally would be the same as discussed for the Proposed Action.

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Section 3.11

Special Status Wildlife Resources

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1 # Acronyms and Abbreviations

°F	degrees Fahrenheit
1969 Lease	Navajo Project Indenture of Lease
AGFD	Arizona Game and Fish Department
APLIC	Avian Powerline Interaction Committee
BART	Best Available Retrofit Technology
BGEPA	Bald and Golden Eagle Protection Act
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BM&LP Railroad	Black Mesa & Lake Powell Railroad
BO	Biological Opinion
CAP	Central Arizona Project
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CO_2	carbon dioxide
COPEC	chemical of potential ecological concern
Co-tenants	Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
Development Fund	Lower Colorado River Basin Development Fund
EIS	Environmental Impact Statement
ERA	Ecological Risk Assessment
ESA	Endangered Species Act of 1973
FCR	Field Contact Representative
FR	Federal Register
HHRA	Human Health Risk Assessment
HQ	hazard quotient
IM	Instruction Memoranda
km	kilometer
KMC	Kayenta Mine Complex
kV	kilovolt
kW	kilowatt
MBTA	Migratory Bird Treaty Act
MW	megawatt
N-Aquifer	Navajo Aquifer
NEPA	National Environmental Policy Act of 1969, as amended
NGS	Navajo Generating Station
NGS Participants	U.S. (Reclamation), Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
NHPA	National Historic Preservation Act
NNEPA	Navajo Nation Environmental Protection Agency
NO_2	nitrogen dioxide

NO_X	nitrogen oxide
OSMRE	Office of Surface Mining Reclamation and Enforcement
PAC	protected activity center
PFR	Partial Federal Replacement
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 microns or less
PWCC	Peabody Western Coal Company
Reclamation	U.S. Bureau of Reclamation
RMPs	Resource Management Plans
ROW	Right-of-way
SGCN	species of greatest conservation need
SO_2	Sulfur dioxide
SRP	Salt River Project Agricultural Improvement and Power District
STS	Southern Transmission System
tpy	tons per year
U.S.	United States
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
WTS	Western Transmission System

Contents

3.11 Special Status Wildlife Resources 3.11-1
3.11.1 Regulatory Framework 3.11-1
3.11.2 Study Areas 3.11-4
3.11.2.1 Proposed Action and Action Alternatives 3.11-4
3.11.2.2 Cumulative 3.11-4
3.11.2.3 Ecological Risk Assessments – Role in Assessing Baseline Risk and Environmental Consequences 3.11-5
3.11.3 Affected Environment 3.11-6
3.11.3.1 Navajo Generating Station 3.11-6
3.11.3.2 Proposed Kayenta Mine Complex 3.11-22
3.11.3.3 Transmission Systems and Communication Sites 3.11-30
3.11.4 Environmental Consequences 3.11-52
3.11.4.1 Issues 3.11-52
3.11.4.2 Assumptions and Impact Methodology 3.11-52
3.11.4.3 Proposed Action 3.11-54
3.11.4.4 Natural Gas Partial Federal Replacement Alternative 3.11-83
3.11.4.5 Renewable Partial Federal Replacement Alternative 3.11-86
3.11.4.6 Tribal Partial Federal Replacement Alternative 3.11-88
3.11.4.7 No Action 3.11-89
3.11.5 References 3.11-91

List of Tables

Table 3.11-1 Relevant Statutes, Regulations, and Policies for Wildlife Species 3.11-1

Table 3.11-2 Other Special Status Wildlife Species Occurrence in the NGS Study Areas............3.11-20

Table 3.11-3 Other Special Status Wildlife Species Occurrence in the Proposed KMC and N-Aquifer Study Areas............3.11-28

Table 3.11-4 Other Special Status Wildlife Species Occurrence along the Transmission System ROWs............3.11-48

Table 3.11-5 Impacts to Other Special Status Wildlife Species Known or with Potential to Occur in the NGS ERA Study Areas under the Proposed Action............3.11-56

Table 3.11-6 Impacts for Other Special Status Wildlife Species within the Proposed KMC and N-Aquifer Study Areas............3.11-62

Table 3.11-7 Impacts for Other Special Status Wildlife Species known or with Potential to Occur Along the WTS and STS............3.11-74

List of Figures

Figure 3.11-1 California Condor Occupied Habitat............3.11-8

Figure 3.11-2 Mexican Spotted Owl Habitat............3.11-11

Figure 3.11-3 Southwestern Willow Flycatcher and Yellow-billed Cuckoo Potential Habitat........3.11-15

Figure 3.11-4 Mexican Spotted Owl Suitable Habitat Proposed KMC............3.11-26

Figure 3.11-5 Black-footed Ferret Potential Habitat along the STS............3.11-31

Figure 3.11-6 Southwestern Willow Flycatcher and Yellow-billed Cuckoo Critical and Potential Habitat along the WTS............3.11-34

Figure 3.11-7 Southwestern Willow Flycatcher and Yellow-billed Cuckoo Critical and Potential Habitat along the STS............3.11-35

Figure 3.11-8 Mojave Desert Tortoise Occupied, Critical, and Potential Habitat along the WTS............3.11-38

Figure 3.11-9 Sonoran Desert Tortoise Potential Habitat and Predicted Habitat Quality along the STS............3.11-41

Figure 3.11-10 Narrow-headed and Northern Mexican Gartersnake Proposed Critical Habitat along the STS............3.11-44

3.11 Special Status Wildlife Resources

3.11.1 Regulatory Framework

Laws, regulations, and policies that directly influence wildlife management decisions for the project primarily are implemented by the U.S. Fish and Wildlife Service (USFWS), Navajo Nation, Hopi Tribe, Bureau of Land Management (BLM), U.S. Forest Service, Arizona Game and Fish Department (AGFD), Utah Division of Wildlife Resources, Office of Surface Mining Reclamation and Enforcement (OSMRE), and Nevada Division of Wildlife. A summary of prominent laws, regulations, directives, and agreements relevant to the proposed Project are included in **Table 3.11-1**.

Table 3.11-1 Relevant Statutes, Regulations, and Policies for Wildlife Species

Statutes, Regulations, and Policies	Summary
Endangered Species Act (ESA) of 1973 (16 United States Code 1531-1544)	The ESA provides broad protection for species of fish, wildlife, and plants listed as threatened or endangered by the USFWS. Provisions are made for listing species, as well as for recovery plans and the designation of critical habitat for listed species. All federal agencies in consultation with and with the assistance of the USFWS, also must use their authorities in furtherance of the purposes of the ESA by carrying out programs for the conservation of listed species. All federal agencies, in consultation with, and assistance of, the USFWS must ensure any action authorized, funded, or carried out by federal agency is not likely to jeopardize the continued existence of an endangered, threatened, or proposed listed species, or result in destruction or adverse modification of critical habitat of a species. Agencies are required to use the best scientific and commercial data available to fulfill this change.
Surface Mining Control and Reclamation Act of 1977	The Surface Mining Control and Reclamation Act of 1977 establishes a program for the regulation of surface mining activities and the reclamation of coal-mined lands, under the administration of the Office of Surface Mining, Reclamation and Enforcement. The law establishes minimum requirements for all coal surface mining on Federal and State lands, including exploration activities and the surface effects of underground mining. Mine operators are required to minimize disturbance and adverse impacts to biological resources and achieve enhancement of these resources where practicable.
Bald and Golden Eagle Protection Act (BGEPA) (16 United States Code, § 668 et seq.)	The BGEPA enacted in 1940 and amended several times since enactment, prohibits anyone, without a permit issued by the Secretary of the Interior, from "taking" bald eagles, including their parts, nests, or eggs. The Act provides criminal penalties for persons who "take, possess, sell, purchase, barter, offer to sell, purchase or barter, transport, export or import, at any time or any manner, any bald eagle... [or any golden eagle], alive or dead, or any part, nest, or egg thereof." The Act defines "take" as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb." In addition to immediate impacts, this definition also covers impacts that result from human-induced alterations initiated around a previously used nest site during a time when eagles are not present, if, upon the eagle's return, such alterations agitate or bother an eagle to a degree that interferes with or interrupts normal breeding, feeding, or sheltering habits, and causes injury, death or nest abandonment (USFWS 2016). Eagle breeding activities and nesting locations are afforded legal protection under the act.
Migratory Bird Treaty Act (MBTA)[1] (16 United States Code 703 et seq.)	The MBTA, originally passed in 1918, implements the U.S. commitment to four bilateral treaties [with Canada, Mexico, Japan, and Russia], or conventions, for the protection of a shared migratory bird resource (16 United States Code 703-712). The MBTA applies only to migratory bird species that are native to the U.S. or its territories. A native migratory bird is defined as one that is present as a result of natural biological or ecological processes. Excluded are species whose presence in the U.S. is solely the result of intentional or unintentional human-assisted introductions. The list of migratory bird species protected by the MBTA appears in

Table 3.11-1 Relevant Statutes, Regulations, and Policies for Wildlife Species

Statutes, Regulations, and Policies	Summary
	50 Code of Federal Regulations 10.13. The MBTA provides that it is unlawful to pursue, hunt, take, capture, kill, possess, sell, purchase, barter, import, export, or transport any migratory bird, or any part, nest, or egg of any such bird, unless authorized under a permit issued by the Secretary of the Interior. Some regulatory exceptions apply. "Take" is defined in regulations as: "pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to pursue, hunt." Nongame species that are excluded from protection under the MBTA include the rock pigeon, Eurasian collared-dove, European starling, and house sparrow. For all other native migratory bird species, the MBTA includes, but is not limited to, the following protections: • A total of 1,007 species of migratory birds and their parts, including eggs, feathers, and nests, are protected. • Proof of intent to violate the MBTA is not required for prosecution. • The MBTA has no consultation process such as Section 7 consultation under the ESA. The MBTA does not permit incidental or unintentional take, such as that provided by Sections 7 and 10 of the ESA.
Executive Order 13186 (66 Federal Register [FR] 3853)	Executive Order 13186 directs federal agencies that take actions that either directly or indirectly effect on migratory birds to develop a Memorandum of Understanding, and to work with the USFWS, and other federal agencies to promote the conservation of migratory bird populations. So far, nine agencies have completed a Memorandum of Understanding with the USFWS under the Executive Order, and several other Memorandums of Understanding are in progress.
Navajo Nation Code Title 17[2]	The Navajo Nation's Title 17 (subchapter 26) classifies wildlife species as big game animals, waterfowl, small game animals, fur-bearing animals, game birds, raptors, invasive species, and endangered species. These codes also establish regulations on unlawful take of these species.
Navajo Nation Golden and Bald Eagle Nest Protection Regulations	These regulations provide protection for golden eagles and bald eagles and their nests on the Navajo Nation by regulating human activities associated with land use, land development, and other activities in close proximity to known eagle nests.
Navajo Nation Raptor Electrocution Prevention Regulations	These regulations implement the Navajo Nation's policy of reducing the likelihood of electrocution of raptors by enforcing raptor-safe power pole design standards for new powerlines and repairs or upgrades to existing power lines within designated Raptor Sensitive Areas. The regulations include BMPs and information on raptor-safe power line designs based on Avian Powerline Interaction Committee (APLIC 2006) standards.
BLM Special Status Species Management Policy 6840 (6840 Policy) (Rel. 6-125)	BLM Manual 6840 contains BLM's special status species management policy and guidance for the conservation of special status species and their habitats. Under this policy, special status species include animal and plant species listed as threatened or endangered, proposed for listing, and candidates for listing under the provisions of the ESA; those listed as sensitive species by a state; and those listed by the BLM State Director as sensitive. The objective of this policy is to ensure actions requiring authorization or approval by the BLM are consistent with the conservation needs of special status species and do not contribute to the need to list nay special status species, under provisions of the ESA.
BLM Instruction Memoranda (IM) 2010-156; UT 2006-096; AZ 2011-005	BLM IM 2010-156 provides direction for complying with the BGEPA, including its implementing regulations (i.e., September 11, 2009, Eagle Rule [Rule] 50 Code of Federal Regulations parts 13 and 22) for golden eagles, and to identify steps that may be necessary within the habitat of golden eagles to ensure environmentally responsible authorization and development of renewable energy resources. This IM primarily addresses golden eagles, because a process to acquire take permits for bald eagles already exists. BLM IM UT 2006-096 provides supplemental planning guidance on raptor best

Table 3.11-1 Relevant Statutes, Regulations, and Policies for Wildlife Species

Statutes, Regulations, and Policies	Summary
	management practices. These raptor best Management practices apply to all ongoing and future land use planning efforts and they implement seasonal and spatial buffers, as well as mitigation, to maintain and enhance raptor nesting and foraging habitat, while allowing other resource uses. BLM IM AZ 2011-005is established as list of BLM sensitive plant and animal species on BLM-administered lands in Arizona in compliance with Manual Section 6840 and to clarify requirements regarding Sensitive Species.
BLM Resource Management Plans (RMPs)	The Western Transmission System (WTS) and Southern Transmission System (STS) and associated communication sites are subject to BLM RMPs where their rights-of-way (ROWs) traverse BLM-administered lands. Applicable RMPs include: the Arizona Strip, Hassayampa, Kanab, St. George, Caliente, and Las Vegas Field Office RMPs and the Aqua Fria National Monument RMP.
U.S. Forest Service Manual 2670	Section 2670 of the U.S. Forest Service Manual directs each Regional Forester to designation sensitive species on lands managed by the U.S. Forest Service. A sensitive species is defined as: a "plant or animal species identified by a Regional Forester for which population viability is a concern, as evidenced by a significant current or predicted downward trend in population numbers or density, or significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution."
U.S Forest Service Land and RMPs	The STS is subject to management standards and guidelines contained in U.S. Forest Service Land and RMPs (Forest Plans) where the transmission line ROW traverses and communication sites are located on National Forest System lands. Applicable Forest Plans include those associated with the Kaibab and Prescott National Forests.
National Park Service Management Policies	Section 4.2.3 "Management of Threatened and Endangered Plants and Animals" of the National Park Service's *Management Policies 2006* (National Park Service 2006) requires the National Park Service to survey for, protect, and strive to recover all species native to the national park system that are listed under the ESA. In addition, the National Park Service is required to inventory, monitor, and manage state and locally listed species in a manner similar to its treatment of federally listed species to the greatest extent possible.
Arizona Administrative Code Title 12, Chapter 4, Articles 3 and 4	Arizona Administrative Code Title 12, Chapter 4, Articles 3 and 4 establish rules for the taking and handling of wildlife and rules for live wildlife.
Arizona Revised Statute Title 17, Chapters 3 and 4	Arizona Revised Statute Title 17, Chapters 3 and 4 establish regulations for the taking and handling of wildlife and conservation projects and federal cooperation.
Utah Rules R657-3, R657-19, and R657-48	Utah Rule R657-3 regulates collection, importation, trasporation , and possession of animals. R657-19 regulates the taking and possesion of nongame mammals. R657-48 establishes the Wildlife Species of Concern and Habitat Designation Advisory Committee; defines its purpose and relationship to local, state, and federal governments, the public, business, and industry functions of the state; defines the Utah Sensitive Species List; and defines the procedure for the (a) designation of wildlife species of concern as part of a process to preclude listing under the ESA; and (b) review, identification and analysis of wildlife habitat designation and management recommendations relating to significant land use development projects.

Table 3.11-1 Relevant Statutes, Regulations, and Policies for Wildlife Species

Statutes, Regulations, and Policies	Summary
Nevada Administrative Code 503.0001-503.104	Nevada Administrative Code 503.0001-503.104 provides definitions for wildlife including “endangered,” “protected,” “sensitive,” and “threatened” species as well as classifications of wildlife, including protected, threated, and sensitive species, and rules on taking of wildlife.

[1] The MBTA does not apply to bird species in families that are not referenced in any of the four treaties underlying the MBTA. These include the grouse, turkey, and quail species.

[2] Applies to the Proposed KMC only. Under the 1969 Lease, the Navajo Nation agreed not to regulate the construction, maintenance or operation of NGS facilities, including the BM&LP Railroad, as well as the WTS and STS on Navajo Nation land.

IM = Instruction Memoranda.

MBTA = Migratory Bird Treaty Act.

3.11.2 Study Areas

3.11.2.1 Proposed Action and Action Alternatives

As described in Chapter 1.0, there are three main components of the Navajo Generating Station (NGS) and proposed Kayenta Mine Complex (KMC) Project: the NGS and associated facilities, the proposed KMC, and the transmission systems and communication sites. To facilitate description of the affected environment and analysis of project effects, a total of nine different study areas divided among the three project components have been identified. Refer to Section 3.0 for a detailed description of these study areas. The project components and their associated study areas are listed below:

Navajo Generating Station:

- NGS Near-field study area
- Northeast Gap Region study area
- Southwest Gap Region study area
- San Juan River study area
- Black Mesa & Lake Powell (BM&LP) Railroad study area

Proposed KMC:

- Proposed KMC study area
- N-Aquifer study area

Transmission Systems:

- WTS study area
- STS study area

3.11.2.2 Cumulative

For special status wildlife resources, the cumulative effects study areas are the same as those described for the Proposed Action and its alternatives. The cumulative effects analysis includes an assessment of total project affects across all study areas plus the effects of other past, present, and reasonably foreseeable actions affecting special status wildlife species within these areas. It should be noted that the actions assessed as part of the cumulative effects analysis may be located outside of the study areas listed above (e.g., mercury emissions associated with sources outside of the U.S.). However, to the extent that the effects of these actions combine with project-related effects to special status wildlife within the nine NGS-KMC study areas listed above, they are assessed as cumulative effects.

3.11.2.3 Ecological Risk Assessments – Role in Assessing Baseline Risk and Environmental Consequences

In order to evaluate total future risks associated with future emissions from the NGS, the proposed KMC, and other cumulative sources, it is necessary to consider the level of risk from chemicals of potential ecological concern (COPECs) currently present in the environment (i.e., the environmental baseline). Baseline conditions capture naturally occurring chemicals; past and on-going emissions and deposition from the NGS and proposed KMC; and past and on-going deposition from other local, regional, global sources up to the year 2020. As described in Section 3.0.3, four Ecological Risk Assessments (ERAs) were performed to evaluate environmental conditions in the vicinity of the NGS and proposed KMC. The NGS Near-field ERA evaluated the potential risk to special status wildlife species based on concentrations of NGS emission COPECs in soil, sediment, and surface water within a 20-kilometer (km) radius deposition area around the NGS plant. The Gap Regions ERA evaluated potential risks associated with baseline conditions as well as future operations of NGS to special status aquatic and aquatic-oriented wildlife species along the Colorado River outside of the NGS Near-field study area in the Northeast Gap Region above Glen Canyon Dam and in the Southwest Gap Region below Glen Canyon Dam. The San Juan River ERA evaluated potential risk from NGS stack emissions on aquatic-oriented wildlife within the San Juan River watershed based on sediment, surface water, and fish tissue concentrations. The KMC ERA evaluated potential risk to special status wildlife species resulting from baseline conditions, proposed future mine operations, NGS emissions, and other cumulative sources of COPECs within the proposed KMC. The determination of the ERA study areas is discussed in Section 3.0.2 and described in detail in **Appendix 3RA**, Ecological and Human Health Risk Assessments. Ecological risk for special status wildlife species that only have potential to occur along the transmission systems is not evaluated. It is assumed that, outside of the NGS Near-field study area, terrestrial species occurring along the WTS and STS corridors would not be affected by NGS emissions.

Exposure of wildlife receptors (terrestrial and aquatic-oriented invertebrates, mammals, and birds) was considered for a variety of representative and special status wildlife species with potential to occur in the study area of each ERA. The exposure pathway evaluated for terrestrial invertebrates included direct contact with COPECs in surface soil. The potential exposure of avian and mammalian receptors (including special status wildlife species) to COPECs in surface soil and food items was evaluated by modeling the ingestion of prey items (i.e., terrestrial invertebrates and small mammals), terrestrial plants, and surface water and the incidental ingestion of soil. Data used to characterize baseline conditions for the ERA study areas around the NGS was obtained from a combination of literature reviews, available data, and field sampling.

Hazard quotients (HQs) are calculated for each COPEC for each species considered. HQs are a unitless ratio of known or predicted COPEC concentrations and the appropriate ecological screening value below which impacts to a given species from exposure to a given COPEC are unlikely. The HQ is not a predictor of risk but rather is an indicator of whether or not there is a potential for risk. More information on how HQs are calculated and what the HQ result means is provided in Section 3.0.3 and in **Appendix 3RA**, Ecological and Human Health Risk Assessments. The HQ valued calculated for exposure to maximum concentrations of COPECs, denoted herein as HQ_{max}, is considered a screening-level HQ. It provides a very conservative indicator of risk because receptors (such as special status wildlife species) would practically never be exposed to maximum concentrations of COPECs in the wild. The HQ value calculated for refined concentrations of COPECs, denoted herein as $HQ_{refined}$, is considered to be a more realistic indicator of ecological risk than HQ_{max}.

If the maximum value of HQ_{max} at the no adverse effects level across all COPECs is less than or equal to (≤) 1, risk to the species is considered negligible. If HQ_{max} is greater than (>) 1, ecological risk is evaluated further using $HQ_{refined}$ for the particular COPEC. If $HQ_{refined}$ is less than (<) 1, risk is considered negligible. Conversely, if $HQ_{refined}$ is greater than or equal to (≥) 1 there is a potential risk to that species from one or more COPECs (**Appendix 3RA**, Ecological and Human Health Risk Assessments). For simplicity, in reporting HQs for species with potential to occur in more than one of the NGS ERA study areas, only the highest HQ values across all COPECs and study areas are provided when risk in each of the study areas is negligible. If the reader desires additional information, such as HQ values for other applicable COPECs or study areas, s/he may review the ERA summary provided in **Appendix 3RA** or the specific ERA reports of interest (Ramboll Environ 2016a,b,c,d). When there is potential risk to a species in one or more study areas, the study area(s) and COPEC(s) with HQs exceeding the risk threshold are identified.

Risks to special status wildlife species associated with baseline conditions are discussed in the Affected Environment section. Risks associated with the Proposed Action, and the Proposed Action when added to baseline conditions, are disclosed in the Environmental Consequence section. It should be noted that all HQs presented for the Proposed Action are associated with the 3-Unit Operation and are considered a worst-case scenario. HQs for the 2-Unit Operation are slightly lower than those for the 3-Unit Operation but, given that ecological risk to special status wildlife species is primarily a factor of baseline conditions and, in one case, other cumulative sources, implementation of the 2-Unit Operation would provide only incremental benefits to special status wildlife relative to the 3-Unit Operation.

3.11.3 Affected Environment

Special status wildlife species include species listed as threatened or endangered under the ESA, species that are candidates or have been proposed for listing under the ESA, species listed in Groups 2 and 3 of the Navajo Endangered Species List, species of cultural importance to the Hopi Tribe, species considered sensitive by the BLM and U.S. Forest Service, and state-listed sensitive species including species of greatest conservation need (SGCN) as identified in state wildlife action plans. Special status amphibian and fish species are addressed in Section 3.13, Special Status Aquatic Species.

This section provides information on the occurrence of federally listed species within the three main components of the project area and their associated study areas listed above. Pertinent life history and habitat information along with a summary of the species' listing and conservation status is provided for each of the threatened, endangered, and candidate species known or with potential to occur in the project area. Occurrence information and analysis of impacts to other special status wildlife species (i.e., BLM-, U.S. Forest Service-, Hopi-, and/or Navajo-designated sensitive species) are provided in tables by project component.

3.11.3.1 Navajo Generating Station

3.11.3.1.1 Federally Listed, Candidate, and Proposed Wildlife Species

Federally listed, proposed, and candidate wildlife species that are known or have potential to occur in the NGS study area include the California condor, Mexican spotted owl, southwestern willow flycatcher, and western yellow-billed cuckoo. Additional information on these species is presented below.

3.11.3.1.1.1 California Condor

Species Occurrence

In the vicinity of NGS and its associated facilities, condors are part of the "Southwest population" of condors, a designated non-essential experimental population. For the purposes of Section 7 of the Endangered Species Act, condors in this population are treated as a proposed species except within

National Parks and National Wildlife Refuges, where they are treated as a threatened species. Critical habitat is not present within the area occupied by the Southwest population.

As evidenced by images of condor telemetry data provided by the Peregrine Fund (Parish 2014, 2013), California condors occasionally fly by NGS, but the vast majority of condor activity occurs in and around Vermilion Cliffs National Monument (where the release site is located), Grand Canyon and Zion National Parks, the Kaibab Plateau and, to a lesser extent, Marble Canyon (**Figure 3.11-1**). Condors occurring in the easternmost portion of Vermilion Cliffs National Monument and along the Colorado River from Glen Canyon Dam downstream to the confluence of the Paria River are within the radius of the NGS Near-field emissions deposition area.

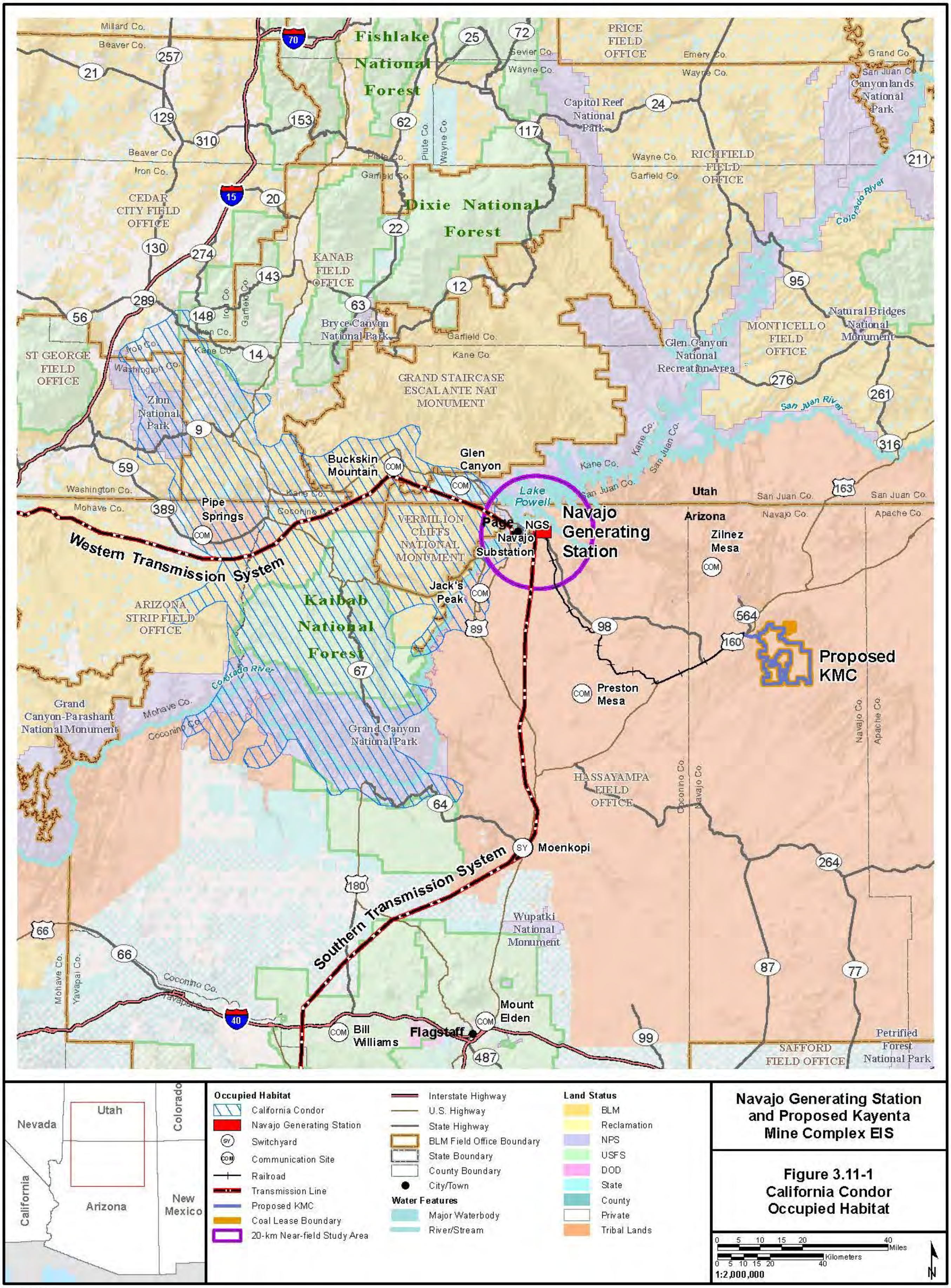
A map showing California condor telemetry relocations of individuals associated with the Southwest experimental non-essential population indicates that eight or nine condor flight paths have traversed the BM&LP Railroad ROW over the last 5 years (Parish 2014, 2013; The Peregrine Fund 2015). The vast majority of telemetry data have been recorded west and north of the railroad. Individuals recorded east of the railroad were on foraging flights as there are no records of condors nesting in this area.

Life History and Habitat Association

California condors are opportunistic scavengers that only feed on carrion. Condors are social feeders with typical foraging behavior consisting of long-distance reconnaissance flights, circle-soaring over a carcass, and hours of waiting at roosts or on the ground near a carcass (USFWS 1996). Condors do not use their sense of smell to locate food but rely on sight and the presence of other scavengers such as eagles and ravens to indicate the presence of food. Prior to Euro-American settlement of North America, condors inhabiting interior California likely fed on mule deer, elk, pronghorn, and smaller mammals. Condors have been observed feeding on 24 different mammal species in the last two centuries, and 95 percent of the diet consisted of cattle, domestic sheep, ground squirrels, mule deer, and horses. Over half of these observations were of condors feeding on cattle carcasses, mostly calves (USFWS 2013a). There also is some evidence that suggests California condors prefer deer over cattle.

California condors have an expansive home range and are capable of travelling from 50 to over 100 miles in a single day. Condors require open habitat for soaring and easily locating feeding opportunities. Condors do not build nests; rather, they move sand, branches, rocks, and other materials around in nest sites to produce an appropriate substrate needed for egg laying (USFWS 2013a). Breeding habitat typically is located in steep remote mountainous or canyon terrain on rock or cliff escarpments at low to moderate elevation.

Condor habitat must support large mammals that provide a source of carrion. Foraging habitats consist of open grasslands, shrublands, and pinyon-juniper woodlands that support populations of deer, elk, and cattle. Condors require large foraging areas because feeding opportunities are limited and often widely distributed across their range. Roosts found in or near both foraging and nesting habitat areas typically consist of large trees or snags with open lateral branches or cliff faces and rock spires with available perches. Because they are such large birds, condors typically select roosting sites near cliffs where updrafts provide adequate lift for them to take flight (AGFD 2012; Snyder and Rea 1998; USFWS 1996).



Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 3.11-1 California Condor Occupied Habitat

Courtship and nest site selection by breeding California condors occurs from December into spring. California condors primarily are a cavity-nesting species and typically nest in cavities located on steep rock formations or in burned out hollows of old-growth conifers (Koford 1953 and Snyder et al. 1986 as cited in USFWS 1996). Nest sites also may include cliff ledges, cup-shaped broken tops of old-growth conifers, and occasionally nests of other species (Snyder et al. 1986; USFWS 1996). Female condors typically lay a single egg between late January and early April. The egg is incubated by both parents and hatches after approximately 56 days. Both parents share responsibilities for feeding the chick. Feeding usually occurs daily for the first 2 months and tapers off thereafter. Condor chicks leave the nest at 2 to 3 months of age, but remain in the vicinity of the nest where they are fed by their parents. Chicks begin to fly at 6 to 7 months of age but do not become fully independent from their parents until the following year. Parent birds occasionally continue to feed a fledgling even after it has begun to make longer flights to foraging grounds. California condors may lay a replacement clutch if their first or even second egg is lost (Harrison and Kiff 1980; Snyder and Hamber 1985). California condors typically do not nest until they are at least 6 years old, and it is a long lived species, living up to 50 years (USFWS 1996).

Listing and Conservation Status

The California condor was designated as endangered on March 11, 1967, under the Endangered Species Preservation Act of 1966 (32 FR 4001). Following passage of the ESA of 1973, the species was listed as endangered under the ESA in 1975 (50 Code of Federal Regulations 17.11). Critical habitat for the California condor was designated in 1976 (41 FR 41914) and subsequently corrected and augmented in 1977 (42 FR 47840). No critical habitat is present within the project area.

A special provision of the ESA allows for the designation of experimental/non-essential populations of listed species, and re-introduction efforts for the condor were developed under this rule. The California condors that occur in the vicinity of NGS are part of the experimental/non-essential population that was reintroduced to the Vermilion Cliffs area of northern Arizona/southern Utah in 1996.

From 1992 to 2012, the primary threats to the Arizona population of California condors were lead poisoning (25 mortalities), predation (7 mortalities), starvation (4 mortalities), and shooting (3 mortalities). During this time, there was a single recorded incident of powerline-related mortality in this population. It is unknown whether this mortality was associated with a high voltage transmission line or with a lower voltage distribution line or whether it was due to collision or electrocution. Pre-release powerline aversion training of captive-reared condors began in 1995 and has proven successful in reducing condors' tendency to associate with power poles. As of 2013, no powerline-associated deaths from blunt-force trauma (i.e., collisions) or electrocutions have occurred since 2007 (USFWS 2013a).

The current recovery plan for the species was issued in April 1996 (Third Revision) and the most recent 5-year Review of the species' status was completed in June 2013. California condor population growth has been steady over the last two decades, and in late 2008 the wild condor population exceeded the captive population for the first time since 1983. As of December 31, 2015, the wild condor population totaled 268 individuals with 155 birds in California, 80 birds in Arizona/Utah, and 33 birds in Baja, Mexico (USFWS 2015a). The wild-fledged population is growing as a result of breeding in the wild by captive-released birds. The first chick fledged in the wild was produced in Arizona in the summer of 2003. Since then, the wild population has continued to grow and 2015 marked the first year in the history of the California Condor Recovery Program that the number of wild-fledged birds exceeded the number of deaths in the free-flying population (USFWS 2015a).

Factors Affecting Species

General factors affecting the California condor and its habitat within the project area are identified in the Listing and Conservation Status section, above. Lead poisoning through ingestion of lead ammunition continues to be the greatest factor affecting the Arizona/Utah population of condors. As of 2013, the most recent information on condor deaths indicated that nearly 50 percent of known deaths in the Arizona/Utah population resulted from lead toxicity (USFWS 2013a).

Due to the proximity of the Southwest population to NGS, baseline ecological risk to the California condor from past and on-going NGS emissions was evaluated qualitatively in the NGS Near-field ERA. Because the condor's diet consists primarily of carrion, exposure to COPECs is expected to be via pathways similar to those evaluated for predatory birds such as the red-tailed hawk. Further, condors are expected to be accidental or occasional visitors to the area thus limiting potential exposure. As even maximum concentrations of COPECs resulted in HQs <1 for the hawk (maximum HQ_{max} value is 0.06 for lead), potential baseline risk to the condor is not expected (**Appendix 3RA**, Ecological and Human Health Risk Assessments) (Ramboll Environ 2016a).

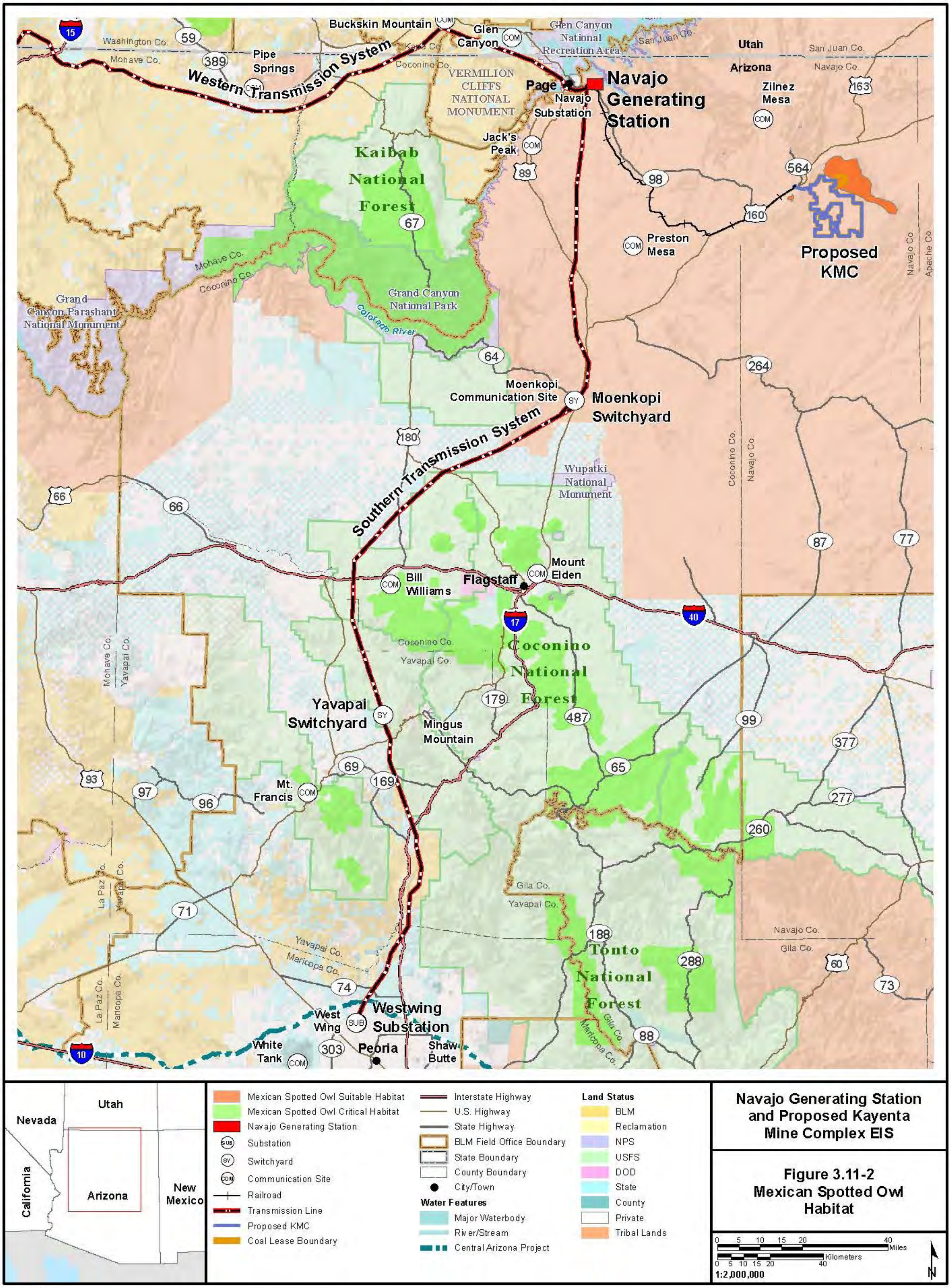
3.11.3.1.1.2 Mexican Spotted Owl

Species Occurrence

The nearest known Mexican spotted owl site to NGS is located in canyon habitat on the north side of Lake Powell, approximately 17 miles northeast of NGS (USFWS 2012). Other known nesting sites occur over 50 miles away in the Grand Canyon. Due to the lack of tree cover, Mexican spotted owls are unlikely to occur in the vicinity of NGS and associated facilities on a regular basis. Although there is some potential for Mexican spotted owls to occur in canyons present within the NGS emissions deposition area (e.g., Navajo Canyon, lower Paria River Canyon), the width of these canyons and general lack of riparian woodlands, mixed conifer forest, pinyon-juniper woodlands, or other woody vegetation in the lower portions of these canyons close to NGS suggests that they do not contain suitable Mexican spotted owl habitat (Willey 2016). Species-specific surveys conducted in lower Paria River Canyon from 2013 to 2015 did not detect any Mexican spotted owls in this area (Willey 2015). Refer to **Figure 3.11-2** for a map of designated critical habitat for Mexican spotted owl habitat in the analysis area.

Life History and Habitat Association

The Mexican spotted owl is one of three recognized subspecies of spotted owl in North America. The Mexican spotted owl is a permanent resident in the interior mountain ranges of western North America, ranging from southern Utah and central Colorado south through the mountains of Arizona, New Mexico, and extreme west Texas. The species typically occupies old growth forest in mixed conifer, pine-oak woodland, deciduous riparian forest, or a combination of these habitats that will support a home range of 1,400 to 4,500 acres (Ehrlich et al. 1988; Gutiérrez et al. 1995). An undisturbed core area, or "protected activity center," of approximately 600 acres centered on the nest site is the currently recommended disturbance buffer (Gutierrez et al. 1995).



Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 3.11-2 Mexican Spotted Owl Habitat

7/20/2016

Mexican spotted owls have been reported at elevations ranging from 3,700 feet above mean sea level to the subalpine transition zone (Ganey et al. 1998; Gutierrez et al. 1995; Johnsgard 1988). The species typically inhabits steep canyons with mature or old growth forest, but they also may occur in canyons with steep cliffs and relatively little forest habitat. Mexican spotted owl habitat typically has a structured canopy, a perennial water source, and a rodent-dominated prey base of adequate size (Gutierrez et al. 1995). The Mexican spotted owl diet varies with geography with owls inhabiting the Colorado Plateau taking more woodrats versus owls occupying montane forest with forest-meadow interfaces consuming more voles (Ward and Block 1995).

Mexican spotted owls exhibit high nest fidelity and construct nests in rock crevices, tree cavities (usually in live trees) or on constructed platforms on tree limbs. In northern Arizona, owls have been reported in both canyon and montane forest situations (Ganey and Dick 1995 cited in: USFWS 2012). Mexican spotted owls also will utilize abandoned raptor or corvid platform nests (Ehrlich et al. 1988; Terres 1980).

Listing and Conservation Status

The Mexican spotted owl was designated as threatened on March 16, 1993 (58 FR 14248-14271) and a Recovery Plan was released on June 6, 1995 (60 FR 29913-29951). A revised Recovery Plan was issued in September 2012. Critical habitat for the Mexican spotted owl, as currently defined, was established on August 31, 2004 (69 FR 53181-53298). In the general vicinity of NGS and associated facilities, critical habitat has been designated in the lower portion of Marble Canyon, throughout Grand Canyon National Park, and in the Kaibab National Forest north of Grand Canyon. There is no designated critical habitat within the NGS Near-field study area. Mexican spotted owls in the vicinity of NGS and associated facilities occur in the Colorado Plateau Ecological Management Unit.

Forest management practices that have altered forest structure and increased the potential for stand-replacing wildfires is one of the primary factors affecting the quality and extent of Mexican spotted owl habitat (USFWS 2012). Wildfire can be detrimental and/or beneficial depending on several factors including whether or not the fire and/or suppression activities are within owl habitat; whether they affect nesting/roosting, foraging, or dispersal habitat; the intensity or severity of the fire; the areal extent, location, and intensity of fire suppression activities; the frequency and cumulative effects of suppression activities; and the time of year (USFWS 2012).

Grazing by domestic and wild ungulates comprises a potential threat to spotted owls when it reduces prey species habitat (e.g., by reducing herbaceous ground cover), adversely affects nesting/roosting habitat (e.g., by limiting regeneration of important tree species, especially in riparian areas), and limits the capacity for resource managers to restore and maintain conditions supporting natural fire regimes within a variety of habitat types (USFWS 2012). This potential threat occurs throughout the owl's range and often during periods of its reproductive cycle when prey availability is most critical.

Energy development and associated infrastructure development, including the construction and maintenance of power lines and roads, may affect owls through habitat loss and fragmentation. Other anthropogenic activities also can threaten the quality and quantity of Mexican spotted owl habitat. Water development can adversely affect owl habitat through permanent flooding of riparian forests as well as stream dewatering and altered flow regimes resulting in loss or degradation of both owl and owl prey habitats, disruption of migration corridors, and inhibited gene flow. For example, the creation of Lake Powell flooded habitat for a potentially large population of owls (Willey and Spotskey 2000).

Noise and disturbance also can threaten the quality of Mexican spotted owl habitat. Although infrequent, noise-producing activities are thought to have relatively little long-term adverse effect on spotted owls. Owls will change behavior and may flush from their perches in response to noise disturbances (Delaney et al. 1999; Swarthout and Steidl 2003). Owl flushing has been observed to be negatively related to distance and positively related to noise level (Delaney et al. 1999). Pater et al. (2009) quantified this response by determining that noise levels greater than approximately 69 decibels on the A-weighted scale had a greater than 60 percent probability of causing an owl to flush. This noise level is approximately twice as loud as ordinary conversation. Although there is little research comparing the relative impact of various noise types, persistent noises are likely to be more disruptive than infrequent noises, and the intensity of disturbance is proportional to the noise level (USFWS 2012).

Climate Change, to the extent that it directly or indirectly affects forest ecosystems through altered temperature, precipitation, and disturbance regimes has potential to affect Mexican spotted owl habitat (USFWS 2012). Mawdsley et al. (2009) identified a number of climate change-related factors that could adversely affect the Mexican spotted owl including shifts in distribution of the owl and its major prey species, potential predators, and competitors along elevational or latitudinal gradients; effects on key demographic parameters such as survival and reproductive rates; changes in predator-prey relationships; loss of habitat due to increased severity of wildfire and bark beetle outbreaks; and increased populations or range expansion of direct competitors such as the barred owl.

A Recovery Plan for the Mexican spotted owl was approved in 1995, and a revision was completed and approved in 2012 (USFWS 2012). Population trends in the Colorado Plateau Ecological Management Unit and throughout the species range remain unclear (USFWS 2012). Data on trends in populations and site occupancy rates are few, and methods and sample sizes differ among studies making comparisons difficult. Nonetheless, results from specific study areas have all noted that the study populations have declined in the recent past (Gutiérrez et al. 2003 cited in: USFWS 2012; Seamans et al. 1999 cited in: USFWS 2012; Stacey and Peery 2002 cited in: USFWS 2012).

Factors Affecting Species

Potential and historic Mexican spotted owl habitat within the project area is likely being affected by several of the factors described as threats under the Listing and Conservation Status section, above. By necessity, maintenance of the STS ROW through forested habitats on and adjacent to the Kaibab and Prescott National Forests continues to fragment this habitat immediately adjacent to the ROW. However, given that the vast majority of these habitats are comprised of pinyon-juniper woodland and the fact that no Protected Activity Centers have been identified along the STS, maintenance of this ROW is unlikely to be causing a substantive impact on Mexican spotted owl habitat. Noise and disturbance associated with continued mining and reclamation operations in the northeastern portion of the proposed KMC has likely resulted in reduced habitat quality for Mexican spotted owl in the historic Protected Activity Centers located closest to these activities. To the extent that increased temperatures and reduced precipitation have adversely affected steep-slope conifer communities, riparian habitats, and/or prey abundance within the NGS Near-field study area, the northeastern portion of Black Mesa, and/or along the WTS and STS, climate change is likely playing a role in degrading Mexican spotted owl habitat quality within the project area.

Due to the potential for Mexican spotted owls to occur in the vicinity of NGS and associated facilities, potential ecological risk to this species from past NGS emissions was evaluated quantitatively in the NGS Near-field ERA. Under baseline conditions, maximum concentrations of all COPECs resulted in a maximum HQ_{max} <1 (HQ = 0.6 for lead and zinc) (Ramboll Environ 2016a). Thus, existing baseline conditions, which include historic NGS emissions, pose no risk to the Mexican spotted owl (**Appendix 3RA**, Ecological and Human Health Risk Assessments).

3.11.3.1.1.3 Southwestern Willow Flycatcher

Species Occurrence

Within the NGS emissions deposition area there are documented occurrences of southwestern willow flycatcher along the Colorado River both upstream and downstream of Glen Canyon Dam. They also have potential to occur wherever suitable riparian habitats are present in this area. Refer to **Figure 3.11-3** for a map of potential and designated critical southwestern willow flycatcher habitat in and near the analysis area.

There have been no documented occurrences of the southwestern willow flycatcher in the vicinity of the BM&LP Railroad. There is potential for this species to occur immediately adjacent to the railroad in riparian habitat associated with Begashibito Wash/Cow Springs.

Life History and Habitat Association

The southwestern willow flycatcher is a neotropical migratory bird species that breeds in the U.S. Southwest and winters in the rain forests of Mexico, Central America, and northern South America. Males generally arrive at breeding areas approximately 1 or 2 weeks before the female and nest building usually begins 1 week thereafter. Nests are constructed as open cup nests approximately 8 centimeters high and 8 centimeters wide and typically are placed in the fork of a branch. Egg-laying can begin as early as late May but typically occurs in early to mid-June. Clutch size is usually 3 or 4 eggs for initial nests. Incubation last between 12 and 13 days from the date the last egg is laid, and eggs typically hatch within 24 to 48 hours of each other. Chicks can be present in the nest from mid-June through early August and fledging typically occurs from late June through mid-August. Adults then depart from breeding areas between mid-August to mid-September (Sogge et al. 1997).

The breeding season diet of southwestern willow flycatchers is almost exclusively insectivorous. Willow flycatchers forage on a wide range of prey taxa commonly including wasps and bees, flies, beetles, butterflies/moths and caterpillars, and spittlebugs (USFWS 2002). Diet studies of adult southwestern willow flycatchers have shown the subspecies' diet to be similar with major prey items ranging from small (e.g., flying ants) to large (e.g., dragonflies) flying insects with bees, flies, and true bugs comprising half of the prey items (DeLay et al. 2002; Drost et al. 1998). Diet can vary between years and among different habitat types. Foraging is done primarily by sallying from a perch to perform aerial hawking and gleaning. Foraging frequently takes place at edges and opening with a habitat patch, or at the top of the upper canopy (Sogge et al. 2010).

The southwestern willow flycatcher is considered a riparian obligate species during the breeding season. Four specific types of riparian communities have been described as southwestern willow flycatcher breeding habitat. The first is comprised of dense stands of willows 10 to 23 feet in height with no distinct overstory. This community is often associated with sedges, rushes, or other herbaceous wetland plants. A second habitat type includes dense stands of salt cedar or Russian olive, up to 33 feet in height. These species form a dense, closed canopy with no distinct understory layer. Native broadleaf-dominated communities form a third habitat type, and the fourth habitat type is a mixture of native and exotic riparian species (Sogge et al. 2010). It should be noted that the potential southwestern willow flycatcher habitat identified in **Figure 3.11-3** is based on the following Southwest Regional Gap Analysis Project (SWReGAP) land cover types: Invasive Southwest Riparian Woodland and Shrubland, North American Warm Desert Lower Montane Riparian Woodland and Shrubland, North American Warm Desert Riparian Mesquite Bosque, North American Warm Desert Riparian Woodland and Shrubland, and Rocky Mountain Lower Montane Riparian Woodland and Shrubland (U.S. Geological Survey 2005, 2004). These data are likely to overestimate potential flycatcher habitat in some areas and underestimate it in others.

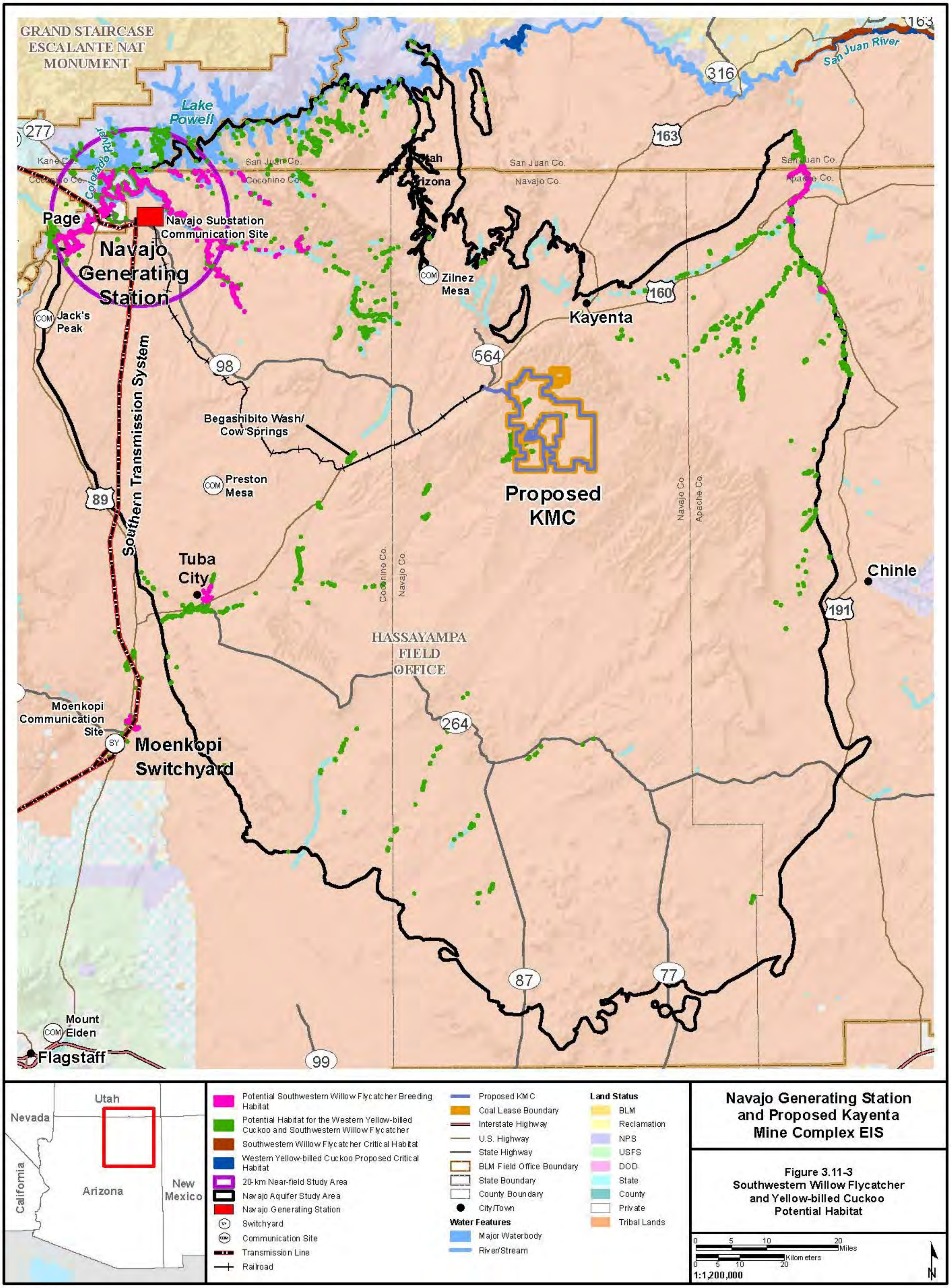


Figure 3.11-3
Southwestern Willow Flycatcher and Yellow-billed Cuckoo Potential Habitat

Regardless of the vegetation species composition, all of these habitats share common structural characteristics. Occupied southwestern willow flycatcher habitats always have dense vegetation in the interior that often are interspersed with small clearings, open water, or areas of sparse shrubs. Habitat patches can vary in size and shape with some occupied areas being relatively dense, linear, contiguous stands and others being large, irregularly shaped mosaics of dense vegetation intermingled with open areas. Habitat patch sizes can range from as little as 2 acres to several hundred or a thousand acres. Southwestern willow flycatchers may occur at elevations as high as 7,875 feet above mean sea level. They also inhabit willow or cottonwood riparian areas that extend into desert regions (Terres 1980). Migration and winter habitat could differ from breeding habitat for this subspecies. During migration, riparian habitat along major southwestern drainages commonly is utilized, but a close association with water may not always exist. These drainages could provide migration habitat for the southwestern willow flycatcher (USFWS 2002).

Listing and Conservation Status

The southwestern willow flycatcher was designated as endangered on February 27, 1995 (60 FR 10693-10715). Critical habitat was later designated on July 22, 1997 (62 FR 39129-39147), and the Final Recovery Plan for the subspecies was issued in August of 2002 with a notice of availability published in the FR on March 5, 2003 (68 FR 10485). A court decision in 2001 resulted in a subsequent Final Rule on Critical Habitat on October 19, 2005 (70 FR 60885-61009). The most recent 5-year review of the subspecies was completed by the USFWS in 2014 (USFWS 2014). On January 3, 2013, the USFWS revised critical habitat for the southwestern willow flycatcher (78 FR 344-534). In total, approximately 1,227 stream miles have been designated as critical habitat, with a lateral extent including riparian areas and streams that occur within the 100-year flood plain or flood-prone areas totaling 208,973 acres. A Final Recovery Plan for the southwestern willow flycatcher was issued in August of 2002 (USFWS 2002).

The most critical threats to the southwestern willow flycatcher include extensive loss, fragmentation, and modification of riparian breeding habitat (Sogge et al.1997), with consequent reductions in population levels (USFWS 2002). This species also is affected directly by factors that impact their survival and reproductive success such as brood parasitism by brown-headed cowbirds, which further reduce population levels. Destruction and modification of riparian habitats primarily have been caused by reduction of surface water and groundwater due to diversion and groundwater pumping, changes in flood and fire regimes due to dams and stream channelization, clearing and controlling vegetation, livestock grazing, changes in water and soil chemistry due to disrupted hydrologic cycles, and establishment of invasive plants (USFWS 2002). More recently, there have been widespread impacts to southwestern willow flycatcher habitat resulting from the release and spread of the tamarisk beetle (*Diorhabda* spp.). Beetle-caused tamarisk defoliation surrounding southwestern willow flycatcher nests results in decreased vegetation and nest cover and may, in turn, result in increased predation and brood parasitism risk and altered microclimate, which, when combined with drought-related reductions in surface water and groundwater, can result in reduced chick survival (Bateman and Johnson 2015; McLeod and Pellegrini 2013 cited in: Bloodworth et al. 2016).

As of 2007, there were data for 288 southwestern willow flycatcher breeding sites and 1,299 nesting territories (Durst et al. 2008). This was a marked difference from the 41 sites and 140 breeding territories that were known in 1993, but this increase was largely a function of the increased survey effort over that time period (Paradzick and Woodward 2003, cited in: Durst et al. 2006). In Arizona, 124 southwestern willow flycatcher breeding sites and 459 territories were known as of 2007 (Durst et al. 2008). This is an increase of nearly 127 percent in number of sites and over 200 percent in number of territories over 10 years from 1998 to 2007 (Durst et al. 2008, 2006). Again, this increase is mostly likely a function of increased survey effort rather than increased population. Determination of actual population trends is difficult due to a lack of annual standardized survey efforts, terminology (e.g., definition of “site”), reporting, and the associated variances in survey effort. As of 2005, it was known that willow flycatchers territories had disappeared from 133 of 275 sites tracked since 1993 (Durst et al. 2006). However, because the majority of the sites in which flycatchers no longer are detected contained only one or two territories, their loss does not greatly affect the overall rangewide territory estimates (Durst et al. 2006).

<u>Factors Affecting Species</u>

Existing and potentially suitable southwestern willow flycatcher habitat within the project area has been and continues to be affected by most, if not all, of the factors identified as threats in the Listing and Conservation Status section, above.

Because the southwestern willow flycatcher is known to occur in the vicinity of NGS and associated facilities and has potential to occur along the Colorado and San Juan rivers, potential ecological risk to this species from past NGS emissions was evaluated quantitatively in the NGS Near-field, Gap Regions, and San Juan River ERAs. Under baseline conditions, maximum concentrations of all COPECs resulted in HQs below 1 for this species. The highest baseline HQ_{max} values calculated for southwestern willow flycatcher were 0.2 for selenium in the Northeast Gap Region and selenium and methylmercury along the San Juan River (**Appendix 3RA,** Ecological and Human Health Risk Assessments). Thus, existing baseline conditions, which include historic NGS emissions, pose negligible risk to the southwestern willow flycatcher.

3.11.3.1.1.4 Western Yellow-billed Cuckoo

<u>Species Occurrence</u>

There are no known occurrences of the western yellow-billed cuckoo in the vicinity of the NGS Plant. Within the NGS emissions deposition area, there is some potential for the species to occur in riparian habitats in side canyons to Lake Powell, such as Navajo Canyon, but it is unlikely that the species composition, structure, and/or areal extent of these habitat patches are sufficient to support breeding pairs. There are known occurrences of the western yellow-billed cuckoo along the San Juan River, but potentially suitable habitat along the San Juan is located nearly 50 miles east-northeast of NGS and associated facilities. The nearest proposed critical habitat is located along the San Juan River over 55 miles from NGS. There also is some potential for the species to occur in the gap regions, but riparian habitat is likely too narrow and limited in extent to support breeding cuckoos in the Southwest Gap Region. The Northeast Gap Region has marginally more potential to support nesting pairs but ends at the confluence of the Colorado and Green rivers in Utah. Proposed critical habitat is located along the Green River upstream of the confluence. Refer to **Figure 3.11-3** for a map of potential and proposed critical western yellow-billed cuckoo habitat in the analysis area.

There are records of occurrence of western yellow-billed cuckoo from Begashibito Wash/Cow Springs, which is located on the Navajo Nation adjacent to the BM&LP Railroad; however, these were not nesting records (Corman and Magill 2000); The woody riparian/wetland habitat in this area appears to be dominated by tamarisk with few native cottonwoods or willows present. As such, this site is probably only used by cuckoos during migration, as it is unlikely to support breeding or nesting western yellow-billed cuckoos.

<u>Life History and Habitat Association</u>

The western yellow-billed cuckoo is a neotropical migrant that spends the winter in South America, east of the Andes and primarily south of the Amazon Basin (78 FR 6121). The winter range and migration routes of the western yellow-billed cuckoo are poorly known, but research indicates that the San Pedro River and the lower Colorado River and its tributaries are migratory corridors (Halterman 2009). In Arizona, most cuckoos do not arrive on their breeding grounds until mid-June (Corman and Wise-Gervais 2005). Nesting typically occurs between late June and late July but may begin as early as May and continue into September (Halterman et al. 2015). Western yellow-billed cuckoos typically have one brood per year (Ehrlich et al. 1988), but double broods have been regularly observed on the lower Colorado and Bill Williams rivers (McNeil et al. 2013).

Western yellow-billed cuckoos are considered riparian obligates because they nest almost exclusively in low- to moderate-elevation riparian woodlands that are located within arid to semiarid landscapes and contain native broadleaf trees and shrubs (Hughes 1999, 79 FR 59992). The species is most commonly associated with cottonwood and willow-dominated vegetation, but the composition of its habitat varies across its range.

Breeding sites often have a distinct overstory of willow, cottonwood, or other broadleaf trees with discernible sub-canopy layers and an understory of mixed trees and shrubs, including tamarisk (Halterman et al. 2015). Western yellow-billed cuckoos in Arizona most commonly occur in cottonwood/willow/ash/mesquite habitat but suitable habitat also may include elderberry, desert willow, mimosa, juniper, and Russian olive (USFWS 2016). In some areas, especially in southern Arizona, cuckoos have been found breeding in narrow stringers of mature trees in drier reaches or in narrow drainages, although at a lower density than in wider riparian habitats (USFWS 2016). Western yellow-billed cuckoos least commonly occur in habitat comprised of greater than 75 percent tamarisk cover (Johnson et al. 2010). Along the lower Colorado River, cuckoos nest in large (i.e., greater than 50-acre) patches of habitat with a dense canopy (McNeil et al. 2013). It should be noted that the potential western yellow-billed cuckoo habitat identified in **Figure 3.11-3** is based on the following Southwest Regional Gap Analysis Project land cover types: Invasive Southwest Riparian Woodland and Shrubland, North American Warm Desert Lower Montane Riparian Woodland and Shrubland, North American Warm Desert Riparian Mesquite Bosque, North American Warm Desert Riparian Woodland and Shrubland, and Rocky Mountain Lower Montane Riparian Woodland and Shrubland. Although it is possible for migrating cuckoos to use these habitats on a transitory basis, the potential habitat, as depicted, probably is an overestimate of potential cuckoo breeding habitat as many of these areas are unsuitable for cuckoo nesting due to insufficient areal extent and/or dominance by exotic vegetation.

Cuckoos eat a variety of prey items with large arthropods (e.g., cicadas, katydids, grasshoppers, and caterpillars) as their primary prey. Other prey includes small lizards, frogs, spiders, tent caterpillars, and a variety of other insects (Halterman et al. 2015). There is evidence to suggest that population levels and breeding may be closely tied to the abundance of certain food items (Halterman 2009; McNeil et al. 2013; and multiple other authors cited in: Halterman et al. 2015).

Listing and Conservation Status

The Western U.S. distinct population segment of the yellow-billed cuckoo (hereafter referred to as western yellow-billed cuckoo) became a candidate species for listing as threatened or endangered on October 30, 2001 (66 FR 54807-54832). On October 3, 2013, the western yellow-billed cuckoo was proposed for listing under the ESA (78 FR 61621-61666). On November 3, 2014, the species was listed as threatened by the USFWS (79 FR 59992-60038). On August 15, 2014, the USFWS proposed critical habitat for the western yellow-billed cuckoo (79 FR 48548-48652).

Habitat loss is the primary threat to the western yellow-billed cuckoo (Corman and Wise-Gervais 2005; Floyd et al. 2007). Western yellow-billed cuckoos appear to require large tracts of contiguous habitat (Sutter et al. 2005), and population declines across the Western U.S. primarily are due to the loss of cottonwood-dominated riparian habitat. This loss primarily is a result of conversion to agriculture, dams and river flow management, bank protection, overgrazing, competition from exotic plants such as tamarisk, urban development including transportation infrastructure, and increased wildfire (Bennett and Keinath 2003; USFWS 2013c). Western yellow-billed cuckoos are further threatened by their low population size, extreme population fluctuations, and patchy distribution (Bennett and Keinath 2003). Heavy pesticide usage during the last 50 years also has likely contributed to population declines by removing prey, directly poisoning birds, and causing egg shell thinning (Bennet and Keinath 2003).

Due to the rarity of western yellow-billed cuckoo habitat and because populations tend to be small and isolated, the remaining populations in western North America are increasingly susceptible to further declines through lack of immigration, chance weather events, fluctuating availability of prey populations, pesticides, collisions with tall vertical structures during migration, spread of the introduced tamarisk leaf beetle as a biocontrol agent in the Southwest, and climate change (USFWS 2013b).

No recovery plan has yet been developed for the western yellow-billed cuckoo. Most locations in Arizona that have western yellow-billed cuckoo populations have not been surveyed regularly enough to provide population trend information. The only two locations with fairly regular monitoring (the Bill Williams and San Pedro rivers) both show downward trends in cuckoo populations (79 FR 60005). The population along the lower Colorado River on the Arizona-California border appears to be increasing with riparian restoration activities in that area, but more years of survey data are needed to determine whether or not that is a long-term trend (79 FR 6005).

Factors Affecting Species

Factors affecting potential western yellow-billed cuckoo habitat within the project area include several of those described as threats in the Listing and Conservation Status section, above. The primary factors likely include loss or conversion of habitat due to river flow management and invasion of exotic invasive riparian vegetation including tamarisk and Russian olive. Overgrazing has likely also led to loss of suitable riparian habitat in portions of the project area. In addition, to the extent that increased temperatures and decreased or more variable precipitation resulting from climate change have reduced the extent of or degraded riparian woodland habitats in the project area, these factors also have reduced the quality and extent of suitable yellow-billed cuckoo habitat in this area.

Because the western yellow-billed cuckoo has potential to occur in the vicinity of NGS and along the Colorado River upstream and downstream of Glen Canyon Dam and is known to occur along the San Juan River, potential ecological risk to this species from past NGS emissions was evaluated quantitatively in the NGS Near-field, Gap Regions, and San Juan River ERAs. Under baseline conditions, maximum concentrations of all COPECs resulted in maximum and refined HQs below 1 for this species in the NGS Near-field study area, San Juan River, as well as in the Northeast and Southwest Gap Regions. The maximum HQmax value calculated for the western yellow-billed cuckoo was 0.8 for methylmercury in the Southwest Gap Region study area (**Appendix 3RA**, Ecological and Human Health Risk Assessments). Thus, existing baseline conditions pose negligible risk to the western yellow-billed cuckoo in these areas.

3.11.3.1.2 Other Special Status Wildlife Species

Other special status wildlife species include species listed in Groups 2 and 3 of the Navajo Endangered Species List that also are not listed under the ESA, BLM-, and U.S. Forest Service-designated sensitive species, and state-listed SGCN at the Tier 1a level for Arizona. Navajo Endangered Species List Group 4 species are identified for species that are considered special status by other federal or state agencies. Similarly, Arizona SGCN at the Tier 1b level are identified for species considered special status by federal or tribal agencies but Tier 1b species are not included if that is their sole designation. Other special status wildlife species with potential to occur in the vicinity of NGS and its associated facilities, including the BM&LP Railroad, and have potential to be affected by NGS emissions or plant operations are listed in **Table 3.11-2**.

Table 3.11-2 Other Special Status Wildlife Species Occurrence in the NGS Study Areas

Species	Status[1]	Occurrence in Study Areas[2]	Habitat and Diet
Desert Bighorn Sheep (*Ovis canadensis nelsoni*)	NESL G3, BLMS	NGS: P RR: P	Desert bighorn sheep occur in cliff and canyon and desert scrub habitats. Their diet comprises mostly grasses but they also eat forbs and browse (Festa-Bianchet 2008).
Houserock Valley Chisel-toothed Kangaroo Rat (*Dipodomys microps leucotis*)	FS, BLMS, SGCN 1b	NGS: P	This kangaroo rat is found in desert valleys dominated by desert scrub habitat. Nests are found in underground burrows. The species is essentially solitary and its diet consists primarily of leaves of terrestrial plants (particularly salt bush) and seeds but it will sometimes eat insects and fungi. Kangaroo rats are nocturnal and active throughout the year (Linzey and NatureServe 2008).
Spotted Bat (*Euderma maculatum*)	BLMS, FS, SGCN 1b	NGS: K RR: P	Spotted bats occur in a wide variety of habitats including: barren/sparsely vegetated, cliff and canyon, desert scrub, herbaceous wetland, open water, riparian, woody riparian and wetlands, and conifer woodland habitats. They are typically solitary and feed primarily on moths (Adams 2003).
Townsend's Big-eared Bat (*Corynorhinus townsendii*)	BLMS, NESL G4	NGS: P RR: P	The Townsend's big-eared bat may occur in desert scrub, herbaceous wetland, open water, woody riparian and wetlands, and conifer woodland habitats. They feed on moths, lacewings, and flies (Adams 2003).
American Dipper (*Cinclus mexicanus*)	NESL G3, SGCN 1b	NGS: P GR: P SJR: P	The American dipper is an aquatic-oriented bird primarily associated with fast-moving, clear, unpolluted streams with cascades, riffles, and waterfalls (Wilson and Kingery 2011). This species primarily feeds on aquatic insects but also may take small fish and fish eggs (Wilson and Kingery 2011).
Bald Eagle (*Haliaeetus leucocephalus*)	FS, BLMS, NESL G2, H, SGCN 1a, BGEPA	NGS: K GR: K SJR: K RR: P	Bald eagles typically nest in trees adjacent to large waterbodies with suitable prey. There are no known bald eagle nests within the project area. Winter roosts are in large trees in forests, river bottoms, or near canyon rims within a few miles of ponds, lakes, and rivers with adequate prey. Wintering eagles occur along the San Juan and Colorado Rivers (Mikesic and Roth 2008). Preferred prey is fish but also consumes birds and mammals, often as carrion (especially in winter). Takes a variety of aquatic and terrestrial mammals, including muskrats, hares, reptiles and amphibians, and a variety of birds including many species of waterfowl and gulls (Buehler 2000).

Table 3.11-2 Other Special Status Wildlife Species Occurrence in the NGS Study Areas

Species	Status[1]	Occurrence in Study Areas[2]	Habitat and Diet
Ferruginous Hawk (*Buteo regalis*)	NESL G3, H, SGCN 1b	NGS: P RR: K	Ferruginous hawks nest in badlands, flat or rolling desert grasslands, and desert scrub. On the Navajo Nation, most nests are located on clay or rock pinnacles, small buttes, and short cliffs. Some nests are placed on juniper trees or on the ground. Preferred prey consists of cottontail rabbits, jackrabbits, prairie dogs, ground squirrels, and gophers (Mikesic and Roth 2008).
Golden Eagle (*Aguila chrysaetos*)	NESL G3, H, BLMS, SGCN 1b, BGEPA	NGS: K RR: K	Golden eagles nest on steep cliffs, 100 feet tall or greater. Nesting cliffs are typically adjacent to foraging habitat of desert grasslands or desert scrub that supports primary prey of cottontail rabbits and jackrabbits (Mikesic and Roth 2008).
American Peregrine Falcon (*Falco peregrinus anatum*)	FS, BLMS, NESL G4, H, SGCN 1a	NGS: K RR: P	Peregrine falcons nest on steep cliffs greater than 100 feet tall within approximately 7 miles of quality foraging habitat comprising extensive wetlands and other open landscapes with available prey. Known to nest in Glen Canyon and the canyon reaches of San Juan, Colorado, and Little Colorado Rivers (Mikesic and Roth 2008). Prey comprised mostly of birds (primarily pigeons and doves) and occasionally mammals (primarily bats) (White et al. 2002).
Western Burrowing Owl (*Athene cunicularia hypugaea*)	BLMS, NESL G4, SGCN 1b	NGS: P RR: P	Burrowing owl breeding habitat includes desert grasslands, desert scrub and pinyon-juniper woodlands. The species nests in ground burrows (typically abandoned prairie dog burrows) in dry open grasslands and grasslands with sparsely distributed junipers (Mikesic and Roth 2008). Primary prey comprised of insects (mainly grasshoppers, crickets, moths, and beetles) and small mammals such as mice, voles, and shrews (Poulin et al. 2011).

1 Status: NESL = Navajo Endangered Species List, G2 = Group 2, G3 = Group 3, G4 = Group 4; H = Hopi Cultural Sensitive Species; FS = Forest Service Sensitive; BLMS = BLM Sensitive; CAS = Conservation Agreement Species; SGCN = State Species of Greatest Conservation Need, 1a = Tier 1a, 1b = Tier 1b; BGEPA = Bald and Golden Eagle Protection Act.

2 Occurrence Categories: NGS = NGS Near-field study area; GR = Gap Region study area; SJR = San Juan River study area; RR = BM&LP Railroad study area; K = Known occurrence based on Natural Heritage Program data, Navajo data, and agency input; P = Potential occurrence based on distribution and habitat information, agency input, the USFWS IPaC system, and/or the AGFD HabiMap utility.

3.11.3.1.2.1 Factors Affecting Other Special Status Wildlife Species

General factors affecting other special status wildlife species within the NGS Near-field study area include habitat loss and degradation associated with residential and recreational development (e.g., the communities of Page, Lechee, and Wahweap, Arizona), and the seasonally high levels of vehicle traffic and human activity associated with these areas. Vehicle traffic associated with tourism and current NGS operations (commuter traffic and chemical deliveries) likely results in some level of direct injury and mortality to small mammals such as kangaroo rats crossing roads and raptors (particularly bald eagles) that feed on roadkill. Bighorn sheep likely avoid developed areas, reducing the amount of functional habitat available for this species in the NGS Near-field study area. Moreover, the presence of the BM&LP Railroad is a barrier to bighorn sheep movement, fragmenting available habitat for this species. It should be noted that the overhead distribution line that runs between NGS and the Lake Pump Station and supplies power to the cooling water intake pumps has been designed and built to be raptor-safe according to standards developed by the Avian Powerline Interaction Committee (2006). Consequently, there is negligible avian electrocution risk associated with this line. Although there is potential for large raptors to be electrocuted by the BM&LP Railroad catenary system, there have been no known electrocutions of raptors or other large birds associated with operation of the railroad to date.

Baseline ecological risk to other special status wildlife species within the NGS Near-field, Gap Regions, and San Juan River study areas was directly assessed only for the bald eagle, which was modeled as a representative piscivorous (fish-eating) species and special status aquatic-oriented species. Under baseline conditions the bald eagle was determined to have HQ_{max} values less than 1 in the Northeast Gap Region and San Juan River study areas, indicating negligible baseline risk to the bald eagle in these areas. However, for the NGS Near-field study area and the Southwest Gap Region, baseline HQ_{max} values for the bald eagle were determined to be 1 and 4, respectively. $HQ_{refined}$ in the NGS Near-field area drops to 0.6, indicating negligible risk to the bald eagle under this more realistic exposure scenario. In the Southwest Gap Region study area, $HQ_{refined}$ = 3, indicating potential baseline risk to the bald eagle from methylmercury exposure in this area. It should be noted that the elevated baseline ecological risk calculated for bald eagles in the Southwest Gap Region resulted from the inclusion of data collected by Walters et al. (2015). The model results for methylmercury in bald eagles were heavily influenced by the high levels of mercury observed in fish species that are prey for bald eagles. However, it questionable whether the results of Walters et al. (2015) investigation are representative of actual baseline conditions (Ramboll Environ 2016c, Appendix A-1D).

Baseline ecological risk to other special status species in the NGS ERA study areas may be inferred from ERA results pertaining to representative wildlife species. In the NGS Near-field study area, all HQ values calculated using maximum COPEC concentrations are below 1 for representative wildlife species, indicating that baseline conditions pose negligible risk to other terrestrial and aquatic-oriented special status species in the vicinity of the NGS (Ramboll Environ 2016a). Similarly, in the Northeast and Southwest Gap Regions and San Juan River study areas, HQ_{max} for all COPEC/receptor combinations are below 1 (Ramboll Environ 2016b,c), indicating that baseline conditions pose negligible risk to other special status wildlife species with potential to occur in these. Refer to **Table 3.11-5** for more detail on representative species used in this analysis.

3.11.3.2 Proposed Kayenta Mine Complex

3.11.3.2.1 Federally Listed, Candidate, and Proposed Wildlife Species

3.11.3.2.1.1 Black-footed Ferret

<u>Species Occurrence</u>

No black-footed ferrets have been documented within the overall project area. There are two known active Gunnison prairie dog colonies within the proposed KMC permit area: Colony PD 17-18 and Colony PD-20. As of 2015, PD 17-18, located in sagebrush shrubland habitat, was approximately 36 acres in size with a population estimate of approximately 14 prairie dogs. PD-20, located in reclaimed grassland habitat, is approximately 25 acres in size with a 2015 population estimate of 57 adult prairie dogs (Ecosystem Management, Inc. 2016). Neither of these colonies is considered large enough to support black-footed ferrets. To the extent that there are Gunnison prairie dog colonies greater than 400 acres in size within the N-Aquifer study area, there is potential for black-footed ferrets to occur there. However, it is very unlikely that any wild populations of the species survive on the Navajo Nation and there have been no observations of ferrets on the Navajo Nation in several decades (Smith and Hazelton 2014).

Life History and Habitat Association

Black-footed ferrets are prairie dog obligates, and prairie dog colonies are the only known habitat that sustains black-footed ferret populations (Biggins et al. 2006). Prairie dog colonies typically are found in short- and mid-grass prairies, and semi-desert areas with mosaics of grass and shrubs (Esch et al. 2005). Ferret-occupied prairie dog colonies typically are on level ground or rolling hills. Suitable soils include clay-loam to unconsolidated gravelly soils, which are more stable for burrow construction by prairie dogs and provide good drainage (Esch et al. 2005). Vegetation typically is a type of wheatgrass-needlegrass, including buffalo grass, blue grama, western wheatgrass, green needlegrass, and patches of forbs and mixed shrubs such as sagebrush and rabbitbrush (Esch et al. 2005).

Ferrets prey on prairie dogs almost exclusively, and depend on prairie dog burrows for thermal cover, predator escape, hunting sites, parturition sites, and rearing of young (Esch et al. 2005). One study found that prairie dog remains constituted 91 percent of analyzed ferret scat (Hillman and Clark 1980). Other prey animals include ground squirrels, cottontail rabbits, deer mice, and possibly birds (NatureServe 2015). It has been estimated that approximately 100 to 150 acres of prairie dog colony are needed to support 1 ferret (Esch et al. 2005). The minimum area required to sustain a ferret is 91 to 235 acres in black-tailed prairie dog habitat (38 prairie dogs/acre) and 413 to 877 acres in white-tailed prairie dog habitat (10 prairie dogs/acre) (Esch et al. 2005), indicating a rather strong and predictable relationship between ferret area requirements and prairie dog density.

Many avian and mammalian predators are attracted to prairie dog colonies where ferrets could be encountered. Studies suggest that coyote, golden eagle, and great horned owls (as well as domestic cats and dogs) opportunistically prey on black-footed ferrets (Hillman and Clark 1980). Ferrets also are susceptible to parasites and disease. Sylvatic plague and canine distemper could pose a serious threat to ferret populations in areas where outbreaks occur among other wild and domestic animals (Hillman and Clark 1980).

Listing and Conservation Status

The black-footed ferret was designated as endangered in 1966. The species was subsequently listed as threatened with extinction under the ESA on March 11, 1967 (32 FR 4001) and as endangered under the ESA on June 2, 1970 (35 FR 8491). No critical habitat has been designated for the species. The USFWS initiated a 5-year species status review for the black-footed ferret on July 7, 2005 (70 FR 39326). The current Black-footed Ferret Recovery Plan was approved in 2013 (USFWS 2013c). This plan replaced the 1978 recovery plan, which was drafted when no extant, wild black-footed ferrets were known to exist.

Black-footed ferrets continue to face a high degree of threat due to potential economic conflicts regarding the ferret's obligatory dependence on prairie dogs, which are widely viewed as pests by agricultural interests. The high degree of threat to black-footed ferrets is largely due to inadequate management and conservation of prairie dogs.

Despite extensive and intensive searches throughout the species historic range, no wild populations of black-footed ferrets have been found following the final capture of the last known wild ferret in Meeteetse, Wyoming, in 1987. It is very unlikely that any undiscovered wild populations of the species remain (USFWS 2013c). As of 2012, there have been 20 black-footed ferret reintroduction projects, which have met with varying success. The size of the resulting populations and population trends are difficult to determine due to the species' nocturnal habits and the logistical challenges and costs associated with the requisite field surveys.

According to USFWS, the recovery of black-footed ferrets will depend upon: 1) the continued efforts of captive breeding facilities to provide animals of suitable quality and quantity for release into the wild, 2) the conservation of prairie dog habitat adequate to sustain ferrets in several populations distributed throughout their historical range, and 3) the management of sylvatic plague to minimize impacts to ferrets at reintroduction sites (USFWS 2013c).

Factors Affecting Species

If any wild black-footed ferrets are present within the project area, it is likely that the primary factor affecting them is continued losses of or local fluctuations in populations of their main prey species, the Gunnison prairie dog, due to sylvatic plague.

With regard to ecological risk, the ERA prepared for the proposed KMC used a food web model to evaluate risk to terrestrial wildlife exposed to baseline contaminant levels. For aquatic- and terrestrial-oriented birds and mammals, possible exposure routes included incidental ingestion of soil, surface water, and/or sediment (as appropriate), as well as food items containing COPECs. The extent of exposure of COPECs via ingestion depends on a number of factors including concentrations of COPECs in food items, size of the receptor, and COPEC bioavailability. Current site-specific tissue data in food items are not available, so concentrations of COPECs in these tissues were estimated using baseline media concentrations and literature-derived uptake factors in the food web model to fill in gaps. Results of the ERA indicated that baseline conditions do not pose an unacceptable risk to the red fox (HQ_{max} <1), a terrestrial carnivore which could be considered a representative species for black-footed ferret (**Appendix 3RA**, Ecological and Human Health Risk Assessments).

3.11.3.2.1.2 California Condor

For information on the California condor's life history and habitat associations, as well as the listing and conservation status of the species, refer to the corresponding discussion under Section 3.11.3.1, NGS and Associated Facilities.

Species Occurrence

There are no records of occurrence for California condor within the proposed KMC. Maps of telemetry relocations of tagged individuals associated with the Southwest experimental non-essential population provided by The Peregrine Fund indicate that three recorded flight paths have been in the general vicinity of the proposed KMC (Parish 2013; The Peregrine Fund 2015). Prior to 2015, the closest of these came within approximately 25 miles of the western edge of the proposed KMC boundary where a condor flew around the east side of White Mesa. Telemetry data from November 2015 shows one flight path extending from the Kaibab Plateau eastward past Four Corners and another flight path extending from Vermilion Cliffs National Monument southeastward over the Black Mesa and proposed KMC to a point north of Chinle and back (The Peregrine Fund 2015).

The Kayenta Mine Permit Renewal Environmental Assessment (OSMRE 2011) reported that it is unlikely that the California condor would use the proposed KMC area as a foraging site, but livestock and big game in the area could provide a limited source of carrion for this species.

Factors Affecting Species

The proposed KMC ERA indicates that baseline conditions do not pose an unacceptable risk to terrestrial carnivores including the red-tailed hawk and red fox. To the extent that these species can be considered representative of the California condor, baseline conditions do not pose an unacceptable risk to this species (**Appendix 3RA,** Ecological and Human Health Risk Assessments).

Because the California condor is unlikely to occur in the proposed KMC and is not at risk from mine emissions or operations, this species is not carried forward in the analysis of environmental consequences for the Proposed Action and Partial Federal Replacement (PFR) alternatives at the proposed KMC.

3.11.3.2.1.3 Mexican Spotted Owl

For information on the Mexican spotted owls' life history and habitat associations, listing and conservation statuses, and recovery, please refer to the corresponding discussion under Section 3.11.3.1, NGS and Associated Facilities.

Species Occurrence

Thirteen years ago, the Mexican spotted owl was considered a year-round resident of the northeastern part of Black Mesa (BIOME 2003) where individuals had been observed within 2 miles of the northeastern boundary of the proposed KMC. Areas in which the species was documented and protected activity centers were designated include upper Yellow Water Canyon, the side canyons of Coal Mine Wash, and upper Moenkopi Wash (BIOME 2003). The upper northeastern portion of the proposed KMC permit area overlaps one of these protected activity centers. Mexican spotted owl surveys conducted in 1999 detected six unpaired male owls and one breeding pair, the latter of which was observed in upper Coal Mine Wash. From 2000 and 2010, no spotted owl surveys were conducted because there was no mine-related activity in the vicinity of the protected activity centers. With implementation of mining activities in coal resource area N-9, spotted owl surveys resumed in 2011 and have been conducted annually since then. In 2015, there were two spotted owl detections within approximately 1.9 miles of coal resource area N-9. These detections are thought to have been of the same individual due to their close temporal and spatial proximity. A follow-up visit the next morning yielded no further detections of the bird(s) and a nest could not be located (Ecosystem Management Inc. 2016). Refer to **Figure 3.11-4** for the general location of Mexican spotted owl habitat in the vicinity of the proposed KMC.

Factors Affecting Species

Mining-related noise and disturbance may be affecting Mexican spotted owl habitat quality within the proposed KMC study area. Night-lighting also can be a source of disturbance for Mexican spotted owls. However, impacts from night-lighting at the proposed KMC are currently and would continue to be minimized through implementation of best practices that ensure the safety of mine workers and compliance with Mine Safety and Health Administration requirements while minimizing light pollution. These practices include the use of directional, shielded, yellow lighting. Because no lights typically are mounted on the draglines that are above the spoil pile elevation, all direct illumination is oriented downward toward the digging face of the excavation and therefore contained within the active pit. The majority of indirect lighting (i.e., reflected light) also is contained within the active pit.

Because Mexican spotted owls are known to occur in the vicinity of the proposed KMC, potential risk to this species from exposure to baseline chemical levels was evaluated quantitatively in the KMC ERA. Under baseline conditions, the maximum HQ_{max} = 1for methyl mercury. Using refined exposures, the HQ for methylmercury dropped to less than 0.01 and the highest $HQ_{refined}$ value was calculated to be 0.3 for copper (Ramboll Environ 2016d). Thus, baseline chemical exposure poses negligible risk to Mexican spotted owls present within the mine lease area and adjacent suitable habitat.

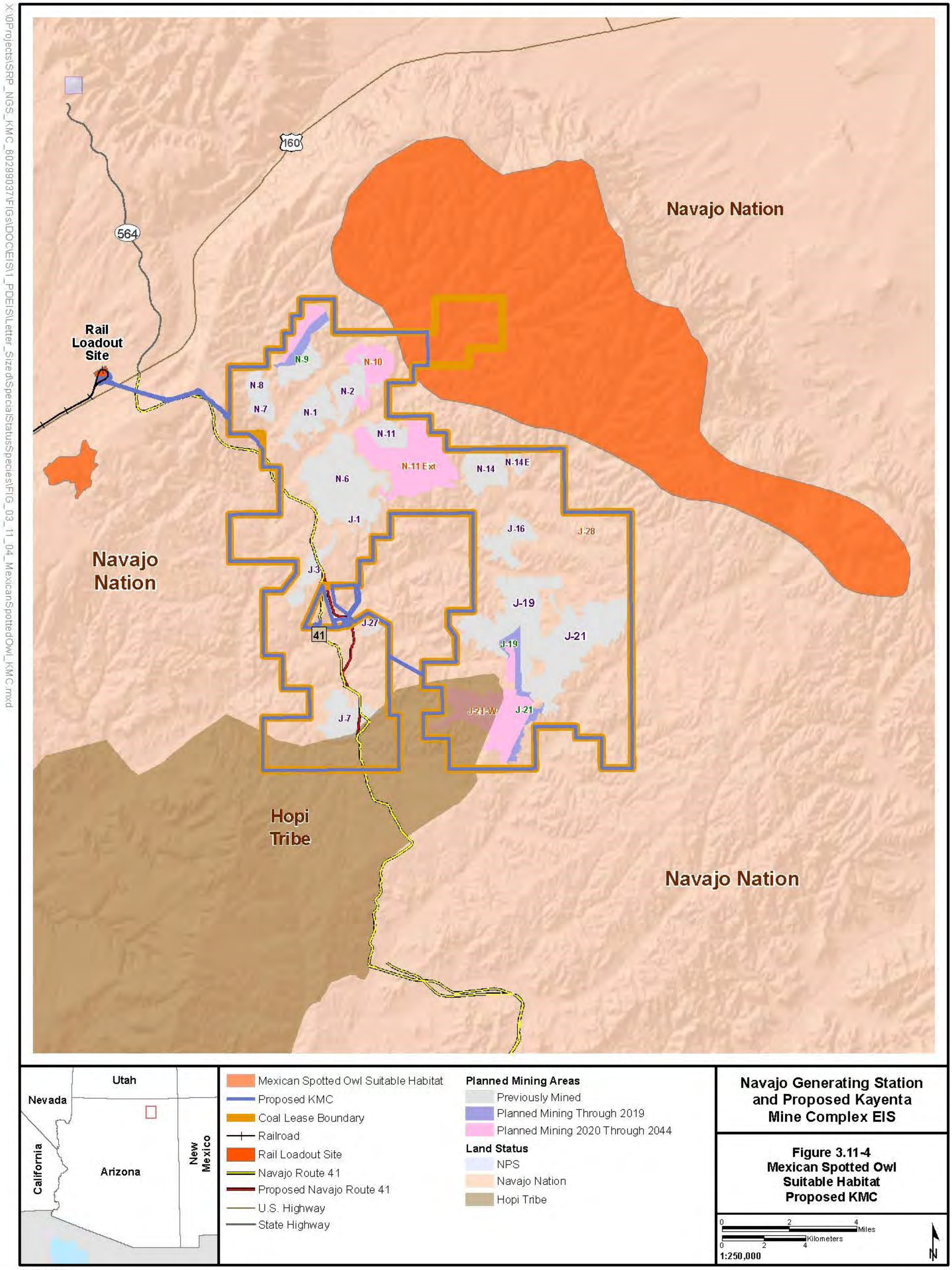


Figure 3.11-4
Mexican Spotted Owl Suitable Habitat Proposed KMC

3.11.3.2.1.4 Southwestern Willow Flycatcher

For information on the southwestern willow flycatcher's life history and habitat associations, listing and conservation statuses, and recovery, please refer to the corresponding discussion under Section 3.11.3.1, NGS and Associated Facilities.

Species Occurrence

Willow flycatchers have been documented on Black Mesa during migration, but it is unknown whether these observations have been of the southwestern subspecies (BIOME 2003). No willow flycatchers have been observed in the proposed KMC during more recent monitoring efforts (e.g., Ecosystem Management, Inc. 2016). Potential habitat is present in the proposed KMC where larger blocks of riparian shrubs and trees occur along perennial streams, springs, and/or seeps in Yellow Water Canyon Wash, Moenkopi Wash, and Dinnebito Wash (BIOME 2003). No critical habitat for the southwestern willow flycatcher occurs in or adjacent to the proposed KMC.

Factors Affecting Species

Although southwestern willow flycatchers currently are not known to occur within the proposed KMC lease area, potentially suitable habitat in the area may be affected by several factors that affect the species range-wide. These factors include brown-headed cowbirds, which are known to occur in the proposed KMC permit area; reduction of surface water and groundwater due to diversions and groundwater pumping; changes in flood and fire regimes due to dams and stream channelization; clearing and controlling vegetation; livestock grazing; changes in water and soil chemistry due to disrupted hydrologic cycles; and establishment of invasive plants.

With regard to baseline ecological risk, the KMC ERA indicated that baseline conditions in the proposed KMC do not pose unacceptable risks to the southwestern willow flycatcher (HQ_{max} = 0.1) (**Appendix 3RA**, Ecological and Human Health Risk Assessments).

3.11.3.2.1.5 Western Yellow-billed Cuckoo

For information on the western yellow-billed cuckoo's life history and habitat associations, listing and conservation statuses, and recovery, refer to the corresponding discussion under Section 3.11.3.1, NGS and Associated Facilities.

Species Occurrence

There are no records of occurrence for western yellow-billed cuckoo within the proposed KMC. The lack of multi-layered, predominately native riparian woodlands in the lease area suggests that it is unlikely cuckoo would nest in the area, though it is possible they could occur there during migration. There are areas of suitable habitat within the larger areas defined by the confined and unconfined portions of the N-Aquifer study area (e.g., such as the riparian woodland at Begashibito Wash/Cow Springs) and, as noted above, there are records of occurrence for non-breeding cuckoos from the Cow Springs area (Corman and Magill 2000). No critical habitat for the western yellow-billed cuckoo occurs within the proposed KMC or surrounding N-Aquifer study area.

Factors Affecting Species

The Proposed KMC ERA indicates that baseline conditions in the proposed KMC do not pose unacceptable risks to the western yellow-billed cuckoo (HQ_{max} = 0.6) (**Appendix 3RA**, Ecological and Human Health Risk Assessments).

3.11.3.2.2 Other Special Status Wildlife Species

Other special status wildlife species with potential to occur in the proposed KMC and surrounding N-Aquifer study area and have potential to be affected by mine operations and/or groundwater pumping, are listed in **Table 3.11-3**.

Table 3.11-3 Other Special Status Wildlife Species Occurrence in the Proposed KMC and N-Aquifer Study Areas

Species	Status[1]	Occurrence [2]	Habitat and Diet
Bald Eagle (*Haliaeetus leucocephalus*)	FS, BLMS, NESL G2, H, SGCN 1a, BGEPA	KMC: K N-Aquifer: K	Bald eagles typically use mature forested riparian habitats associated with perennial waterbodies. However, similar to the western yellow-billed cuckoo, existing riparian habitats found in these areas are unlikely to support nesting eagles and, therefore, this species is considered a winter migrant within the proposed KMC (USFWS 2015b – IPaC, Kayenta Mine ERA). Within the proposed KMC study area, bald eagles also may occur in pinyon-juniper habitat. Bald eagles are mainly piscivorous, but their diet also includes waterfowl and carrion.
Ferruginous Hawk (*Buteo regalis*)	NESL G3, H, SGCN 1b	KMC: K N-Aquifer: K	Ferruginous hawks are considered year-round residents on the Navajo Nation (Mikesic and Roth 2008). Ferruginous hawks are typically found within badlands, grasslands and desert scrub habitats and may nest in pinyon and juniper trees on the edges of these habitats. They are carnivores and typically prey upon cottontail and jackrabbits, prairie dogs, ground squirrels and gophers (Mikesic and Roth 2008). No known nest sites have been documented with the proposed KMC.
Golden Eagle (*Aguila chrysaetos*)	NESL G3, H, BLMS, SGCN 1b, BGEPA	KMC: K N-Aquifer: K	Golden eagles are year-round residents within these areas (USFWS 2015b – IPaC). Nesting habitat includes cliff substrates within desert grasslands or desert scrub habitats (Mikesic and Roth 2008). No nesting has been documented within the proposed KMC.
Northern Goshawk (*Accipiter gentilis*)	FS, BLMS, NESL G4, H, SGCN 1b	KMC: K N-Aquifer: K	Northern goshawks are breeding residents within the proposed KMC and N-Aquifer study areas and their habitat consists of mature conifer or mixed-conifer forests within drainages, canyon bottoms, or north-facing slopes (Mikesic and Roth 2008). Goshawks feed mainly on small birds (band-tailed pigeons, mourning doves, Steller's jays, and northern flickers) and small mammals (squirrels and cottontails) (AGFD 2003). Peabody Western Coal Company (PWCC) conducts annual surveys to determine the presence or absence of goshawks immediately adjacent to the N-9 and J-21 active mine sites. Northern goshawks have not been detected during these survey efforts.

Table 3.11-3 Other Special Status Wildlife Species Occurrence in the Proposed KMC and N-Aquifer Study Areas

Species	Status[1]	Occurrence [2]	Habitat and Diet
Peregrine Falcon (*Falco peregrinus*)	FS, BLMS, NESL G4, H, SGCN 1a	KMC: K N-Aquifer: K	Peregrine falcons are considered breeding residents within the proposed KMC and N-Aquifer study areas. Nesting sites include cliff substrates; however, no known nest sites have been documented within the proposed KMC study area. Peregrine falcons feed primarily on other birds and occasionally on bats.
Western Burrowing Owl (*Athene cunicularia hypugea*)	BLMS, NESL G4, SGCN 1b	KMC: P N-Aquifer: K	Burrowing owls have potential to occur within the proposed KMC and are known to occur in the N-Aquifer study area during the breeding season (USFWS 2015b – IPaC, OSMRE 2011). Burrowing owls inhabit small mammal burrows (most commonly prairie-dog burrows) within grassland and desert scrub habitats (Mikesic and Roth 2008). Primary food items include In large insects and small mammals, as well as fish, reptiles, amphibians, birds and prickly pear cactus seeds (AGFD 2001). There are two known active Gunnison prairie dog colonies within the proposed KMC: Colony PD 17-18 and Colony PD-20. As of 2015, PD 17-18, located in sagebrush shrubland habitat, was approximately 36 acres in size with a population estimate of approximately 14 prairie dogs. PD-20, located in reclaimed grassland habitat, is approximately 25 acres in size with a 2015 population estimate of 57 adult prairie dogs (Ecosystem Management Inc. 2016). Although these colonies may provide suitable burrowing owl nesting habitat, no burrowing owls have been documented within the proposed KMC.

[1] Status: NESL = Navajo Endangered Species List, G2 = Group 2, G3 = Group 3, G4 = Group 4; H = Hopi Cultural Sensitive Species; FS = Forest Service Sensitive; BLMS = BLM Sensitive; CAS = Conservation Agreement Species; SGCN = State Species of Greatest Conservation Need, 1a = Tier 1a, 1b = Tier 1b; BGEPA = Bald and Golden Eagle Protection Act.

[2] Occurrence Categories: KMC = Proposed KMC study area; N-Aquifer = N-Aquifer study area; K = Known occurrence based on Natural Heritage Program data, Navajo data, and agency input; P = Potential occurrence based on distribution and habitat information, agency input, the USFWS IPaC system, and/or the AGFD HabiMap utility.

The main factors affecting other special status species within the proposed KMC study area are those related to existing mining and reclamation activities. Mining and associated vehicle use and human activity reduce or degrade potential nesting and/or foraging habitat for all six of the special status raptors listed in **Table 3.11-3**. To the extent that reclaimed areas are occupied by small mammals, these areas provide foraging habitat for bald and golden eagles and the ferruginous hawk. Reclaimed areas with fossorial mammal populations (e.g., Gunnison prairie dog, ground squirrels) and insects provide potential nesting and foraging habitat for burrowing owls.

The KMC ERA indicated that baseline conditions in the proposed KMC pose negligible risks to the bald eagle (HQ_{max} <1) and representatives of the other special status raptor species listed in **Table 3.11-3**, such as the red-tailed hawk (HQ_{max} <1) and Mexican spotted owl ($HQ_{refined}$ <1) (Ramboll Environ 2016d).

3.11.3.3 Transmission Systems and Communication Sites

3.11.3.3.1 Federally Listed, Candidate, and Proposed Wildlife Species

3.11.3.3.1.1 Black-footed Ferret

For information on the black-footed ferret's life history and habitat associations, listing and conservation statuses, and recovery, refer to the corresponding discussion under Section 3.11.2.3, Kayenta Mine.

Species Occurrence

No black-footed ferrets have been documented within the overall project analysis area. Prairie dogs do not occur proximate to the WTS and STS in northeastern Arizona, or to the WTS in southwestern Utah and southeastern Nevada. Consequently, there have been no black-footed ferret introductions in this area, and there is little or no potential for ferrets to occur along the WTS. Black-footed ferrets have been introduced on the Espee Ranch northwest of Flagstaff in Coconino County, Arizona. This population is located approximately 18 miles northwest of the STS where it crosses State Highway 64 north of Williams, Arizona. Seventy-seven ferrets were released in this area in 2007 (USFWS 2013c), and an additional 25 ferrets were released there in 2014 (AGFD 2014). Female ferrets typically remain on the natal colony and males typically do not move more than 4.3 miles (Miller et al. 1996). Young ferrets dispersing in the fall can make more extensive movements, but it is unlikely that ferrets will colonize the STS ROW as the ROW is approximately 500 feet higher in elevation and predominately surrounded by pinyon-juniper woodland rather than the grassland habitats typical of the large Gunnison prairie dog colonies at Espee Ranch. **Figure 3.11-5** provides a map of the Espee Ranch release site and potential habitat (based on the distribution of Gunnison's prairie dog) in the analysis area.

Factors Affecting Species

It is unknown whether black-footed ferrets were present along the STS at the time it was constructed. If so, the main factor affecting the species was likely the distribution and abundance of the Gunnison prairie dog. Construction and operation of the STS is unlikely to have had a substantive adverse effect on prairie dog populations. However, to the extent that prairie dog populations in and along the STS corridor may have been adversely affected by sylvatic plague or depredated by adjacent ranching interests, the resulting reduction in prairie dog populations would also have impacted any black-footed ferrets associated with these colonies.

3.11.3.3.1.2 California Condor

For information on the California condor's life history and habitat associations and factors affecting the species recovery, refer to the corresponding discussion under Section 3.11.3.

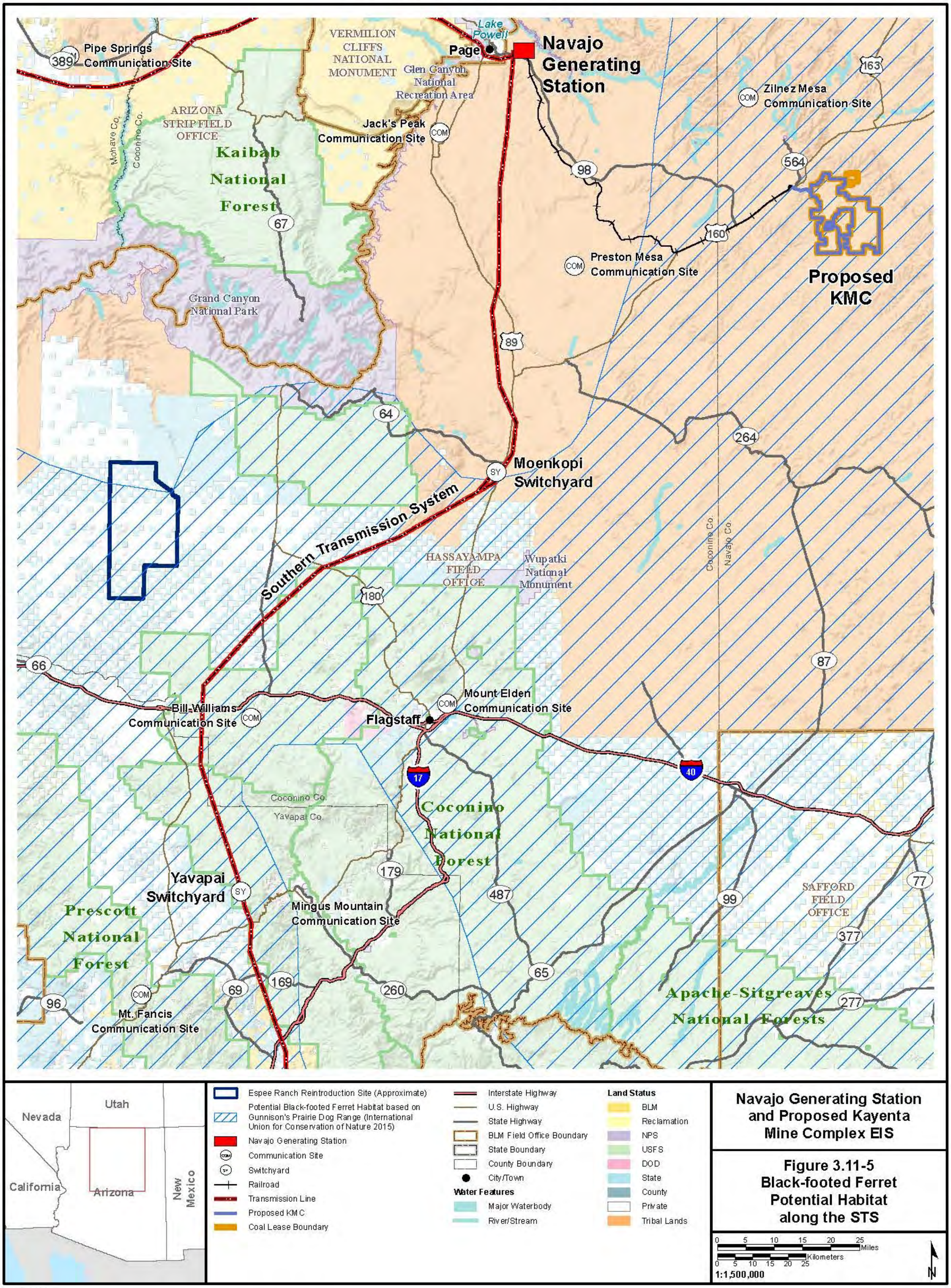


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Figure 3.11-5
Black-footed Ferret Potential Habitat along the STS

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Species Occurrence

Maps of California condor telemetry data from 2009, 2011, 2012, and 2015 show eight or nine condor flight paths traversing the STS alignment (Parish 2013; The Peregrine Fund 2015). A map of 2013 telemetry data shows no relocations east of U.S. Highway 89 (Parish 2014). In contrast, the 2009, 2011, 2012, and 2015 flight path maps show numerous crossings of the WTS as tagged birds moved between the Vermilion Cliffs introduction site in Arizona and concentration areas in Marble Canyon, Grand Canyon, and the western escarpment of the Kaibab Plateau northward to the Vermilion Cliffs and Zion National Park in Utah (Parish 2013; The Peregrine Fund 2015). Although the 2013 and 2015 telemetry data show a relative lack of condor locations in the immediate vicinity of the WTS, it is clear from the earlier flight path data that condors traverse the transmission line ROW on a regular basis and likely forage throughout the area.

Listing and Conservation Status

In southern Utah, northwestern Arizona and southern Nevada, Interstate 15 (I-15), Interstate-515, and U.S. Highway 93 form the western boundary of the California condor's experimental non-essential population, i.e., the 10(j) boundary. The WTS traverses I-15 in southwestern Utah and remains to the west of I-15 through the northwestern corner of Arizona and through southern Nevada to a point just south of the Crystal Substation, where it crosses back to the east side of I-15. Southeast of Henderson, Nevada, the WTS crosses Interstate-515. Condors are listed as endangered everywhere that they occur and west and south (i.e., outside) of the 10(j) boundary, the species enjoys the full protection of that listing. Within the 10(j) area (i.e., east and north of the boundary described above), ESA section 9 prohibitions apply only to incidents of intentional take. These prohibitions do not apply when take is unavoidable and unintentional, provided that such take is non-negligent and incidental to lawful activity, and the take is reported as soon as possible. Other aspects of this species listing and conservation status are as described in Section 3.11.2.2, above.

Factors Affecting Species

Construction of the WTS and STS pre-dated the introduction of California condors in the Vermilion Cliffs and, thus, would have had no effect on this species. On-going operations and maintenance of the WTS and the northern portion of the STS involve periodic aerial inspections of the transmission line. Such inspections are infrequent, occurring approximately every 5 years along the WTS and annually along the STS (**Appendix 1B**). Whereas the passage of a helicopter between 50 and 300 feet above and adjacent to these transmission lines has the potential to disturb condors flying or foraging in the area at the time, the infrequency and short duration of disturbance associated with these inspections likely render the impacts of these inspections negligible. The primary factor affecting condors along the WTS is lead poisoning associated with consuming animals killed by lead ammunition.

3.11.3.3.1.3 Mexican Spotted Owl

For information on the Mexican spotted owls' life history and habitat associations, listing and conservation statuses, and factors affecting species recovery, refer to the corresponding discussion under Section 3.11.3.

Species Occurrence

The WTS ROW comes within approximately 8 miles of Mexican spotted owl critical habitat in Grand Staircase-Escalante National Monument and within 13 miles of critical habitat located in the canyon country around Mount Canaan and Zion National Park north of Colorado City, Arizona. However, the transmission line itself is located in extremely arid habitat, largely devoid of coniferous forests and perennial water. There are no records of occurrence for Mexican spotted owl along the WTS ROW. Moreover, aerial photo interpretation indicates that there is little, if any, suitable spotted owl habitat crossed by the transmission line. Accordingly, recent survey efforts in portions of Paria River Canyon and Kanab Creek Canyon traversed by the WTS did not detect any spotted owls in these areas (Willey 2015). Consequently, it is unlikely that the Mexican spotted owl occurs along the WTS.

The STS passes within a few miles of designated critical habitat for the Mexican spotted owl in the Kaibab National Forest (**Figure 3.11-2**); however, there are no known records of occurrence for this species on or immediately adjacent to the transmission line ROW. Although habitat within the ROW likely is unsuitable for nesting owls, given the proximity of critical habitat and other potentially suitable habitat along portions of the line, there is potential for owls to occur in and immediately adjacent to the STS on a transitory basis during foraging flights or dispersal. Two of the STS communication sites, Bill Williams and Mt. Elden, are located within the boundaries of designated critical habitat for Mexican spotted owl; however, these sites and associated access roads do not contain the primary constituent elements that define critical habitat for this species.

<u>Factors Affecting Species</u>

By necessity, construction and maintenance of the STS ROW through forested habitats on and adjacent to the Kaibab and Prescott National Forests has fragmented spotted owl habitat immediately adjacent to the ROW. However, given that the vast majority of these habitats are comprised of pinyon-juniper woodland and the fact that no protected activity centers (PACs) have been identified along the STS, maintenance of this ROW is unlikely to be causing a substantive impact on Mexican spotted owls. To the extent that increased temperatures and reduced precipitation have adversely affected steep-slope conifer communities, riparian habitats, and/or prey abundance along the WTS and STS, climate change is likely playing a role in degrading Mexican spotted owl habitat quality within and adjacent to the transmission line corridors.

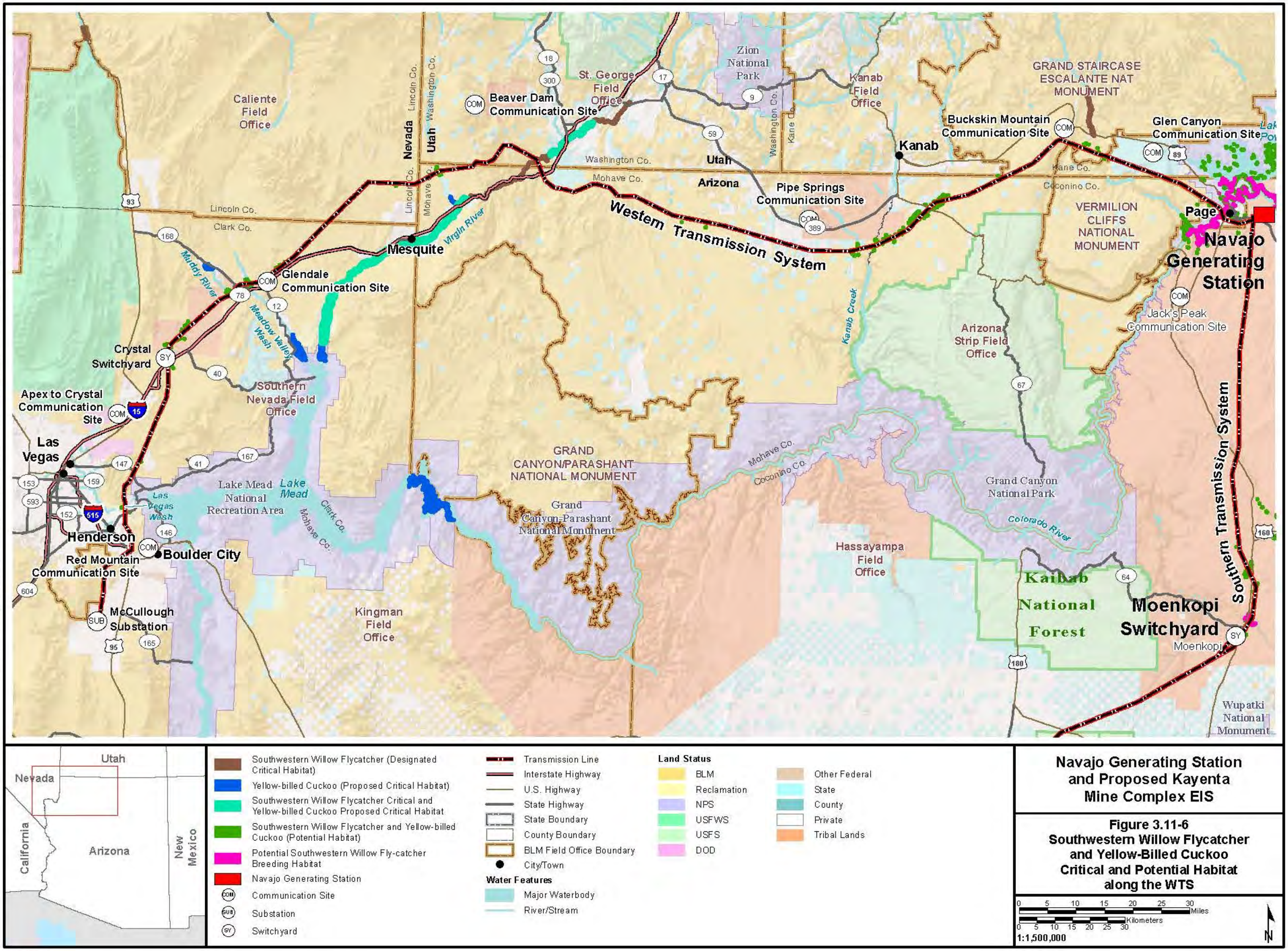
3.11.3.3.1.4 Southwestern Willow Flycatcher

For information on the southwestern willow flycatcher's life history and habitat associations, listing and conservation statuses, and factors affecting species recovery, refer to the corresponding discussion under Section 3.11.3.

<u>Species Occurrence</u>

The WTS traverses potentially suitable southwestern willow flycatcher habitat in a number of locations (**Figure 3.11-6**) starting where the line crosses the Colorado River just west of Page, Arizona. Critical habitat has been designated in Cottonwood Canyon, a tributary to the Paria River, approximately 3 miles north of where the transmission line crosses this drainage. However, potentially suitable habitat does not occur in the portion of the drainage crossed by the transmission line. Similarly, potentially suitable riparian habitat appears to be lacking where the WTS crosses Kanab Creek. Farther to the west, the WTS crosses designated critical habitat where it traverses the Virgin River southwest of St. George, Utah. The species also may occur along the WTS where it crosses Meadow Valley Wash and the Muddy River on the Moapa Indian Reservation and where it crosses Las Vegas Wash near Henderson, Nevada. Documented occurrences of southwestern willow flycatcher are known from Horseshoe Bend on the Colorado River approximately 1.5 miles from the WTS crossing, along Cottonwood Creek approximately 5 miles north of the WTS, along the Virgin River, and along Las Vegas Wash. The southwestern willow flycatcher is a confirmed breeder along the Muddy River in Nevada (Floyd et al. 2007).

The STS does not traverse any designated critical habitat for the southwestern willow flycatcher. However, it does cross potentially suitable riparian habitat located along the Verde River and the Agua Fria River (**Figure 3.11-7**). There is a record of occurrence for the species within 1.5 miles of the STS just south of Lake Pleasant in Maricopa County, Arizona.



Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 3.11-6 Southwestern Willow Flycatcher and Yellow-Billed Cuckoo Critical and Potential Habitat along the WTS

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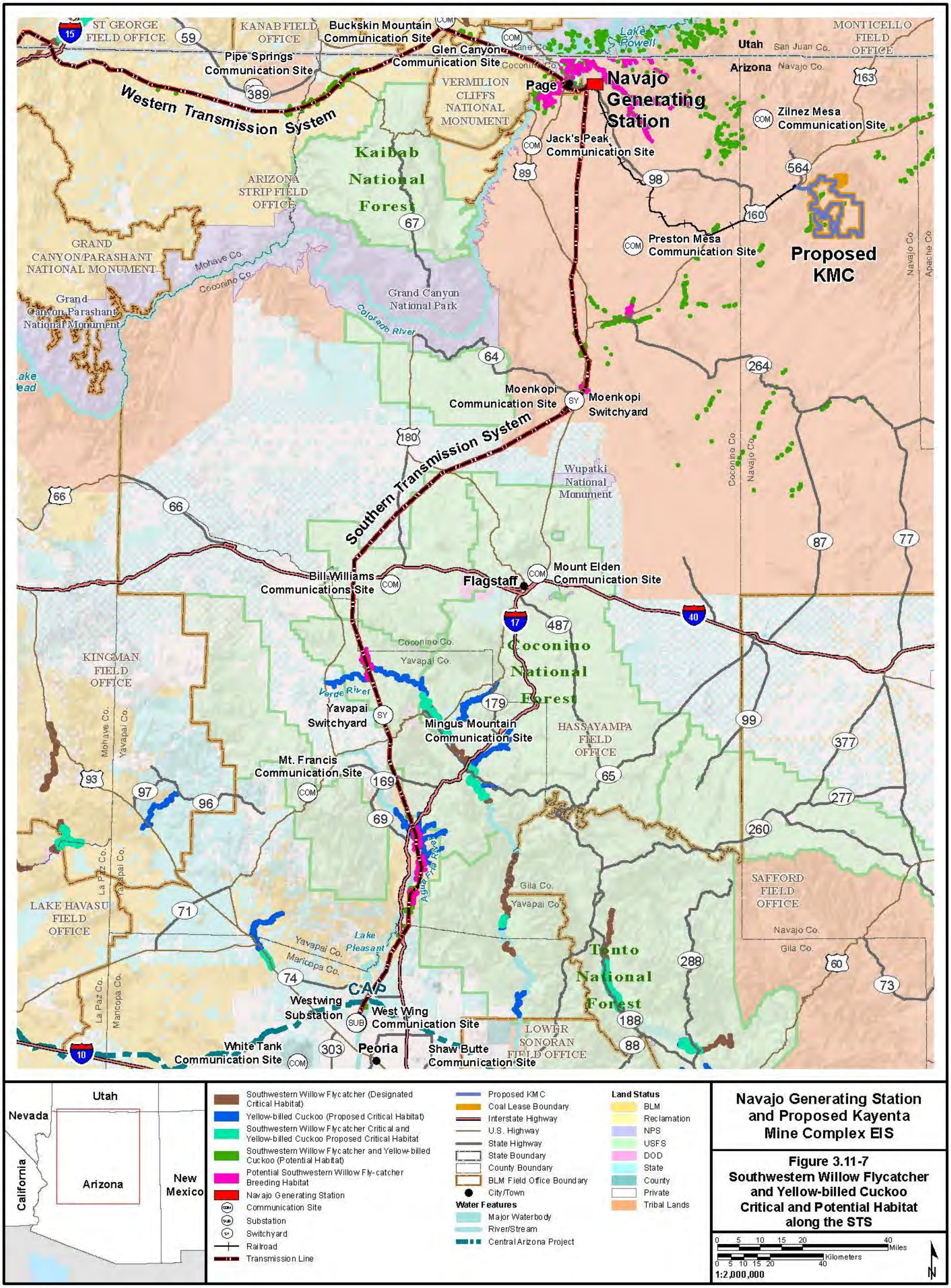

Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 3.11-7
Southwestern Willow Flycatcher and Yellow-billed Cuckoo Critical and Potential Habitat along the STS

Factors Affecting Species

Because the WTS and STS span riparian habitats capable of supporting southwestern willow flycatchers, the original construction and on-going maintenance of these transmission lines has likely had minimal impacts on this species and its habitat. Aerial inspections of these lines have the potential to disturb nesting flycatchers if the inspections are conducted during the species' breeding season, but these disturbances are infrequent (every 5 years for the WTS and annually for the STS) and of short duration. Other factors affecting southwestern willow flycatchers along the transmission systems likely include changes in flood and fire regimes due to stream channelization, livestock grazing, changes in water and soil chemistry due to disrupted hydrologic cycles, and establishment of invasive plants. Another factor likely affecting southwestern willow flycatchers along the WTS and STS is brood parasitism by brown-headed cowbirds, which is known to affect nestling survival and result in reduced population levels. In addition, to the extent that increased temperatures and decreased or more variable precipitation has reduced the extent of or degraded riparian woodland habitats in the action area, it also has reduced the quality and extent of suitable yellow-billed cuckoo habitat in this area.

3.11.3.3.1.5 Western Yellow-billed Cuckoo

For information on the western yellow-billed cuckoo's life history and habitat associations, listing and conservation statuses, and factors affecting species recovery, refer to the corresponding discussion under Section 3.11.3.

Species Occurrence

The western yellow-billed cuckoo has potential to occur in multiple locations along the WTS and STS where these lines cross proposed critical habitat. Along the WTS, the western yellow-billed cuckoo may occur in proposed critical habitat along the Virgin River, and it has been documented along the lower Virgin River in Meadow Valley Wash and in Las Vegas Wash (Great Basin Bird Observatory 2010; Nevada Natural Heritage Program 2014). Along the STS the species may occur in proposed critical habitat along the Verde and Agua Fria rivers.

Factors Affecting Species

Similar to the southwestern willow flycatcher, the primary factors affecting western yellow-billed cuckoos along the WTS and STS likely include loss or conversion of habitat due to river flow management and invasion of exotic invasive riparian vegetation including tamarisk and Russian olive. Overgrazing has likely also led to loss and degradation of suitable riparian habitat along portions of the transmission line corridors. To the extent that increased temperatures and decreased or more variable precipitation has reduced the extent of or degraded riparian woodland habitats along the transmission lines, it also has reduced the quality and extent of suitable yellow-billed cuckoo habitat in these areas.

3.11.3.3.1.6 Mojave Desert Tortoise

Species Occurrence

Potentially suitable habitat for the Mojave desert tortoise is prevalent along the WTS, covering approximately 136 miles of the ROW from the Hurricane Cliffs in Mohave County, Arizona, to the southern terminus of the line in the Eldorado Valley, Clark County, Nevada. Within this area, designated critical habitat is present along approximately 46 miles of the ROW. There have been numerous records of occurrence for desert tortoise adjacent to portions of the line that are collocated with other existing and proposed linear utilities. Potential Mojave desert tortoise habitat has been modeled by the U.S. Geological Survey with habitat values ranging from 0.0 to 1.0 (Nussear et al. 2009). Habitat values of 0.6 and greater are considered suitable habitat for this species. In addition, a field-based habitat assessment specific to the NGS-KMC Project was completed for the portion of the WTS located in U.S. Geological Survey-modeled suitable habitat that has not undergone recent tortoise surveys. This habitat assessment included ground-truthing Southwest Regional Gap Analysis Project and LANDFIRE land cover data, evaluating adjacent land uses, and determining whether habitat was suitable, marginal, or unsuitable. Habitat suitability was based on key habitat parameters derived from a review of pertinent literature including current published information, habitat models, and the primary constituent elements of Mojave desert tortoise critical habitat as determined by the USFWS. The habitat assessment covered approximately 55 miles of the WTS ROW and found that 11 percent of the study plots did not agree with Southwest Regional Gap Analysis Project land cover mapping. It found that approximately 32.5 miles of this portion of the ROW comprise suitable Mojave desert tortoise habitat, 20.7 miles contain unsuitable habitat, and 1.8 miles are of marginal habitat quality (Logan Simpson 2015a). A map of Mojave desert tortoise habitat along the WTS, including the results of the 2015 field-based habitat assessment, is provided on **Figure 3.11-8**. Occupied habitat shown on this map is based on buffered locations of live tortoise observations from protocol-level tortoise surveys conducted for other existing and proposed linear utility projects located in the same corridor adjacent to the WTS. The Mojave desert tortoise does not occur along the STS.

Life History and Habitat Association

The Mojave population of desert tortoise is a long-lived species with a maximum lifespan estimated at greater than 50 years, although tortoises often survive for only 20 to 25 years of adulthood (Germano 1994). The Mojave desert tortoise mating season typically begins in February or March when they emerge from hibernation but can last into fall. Between one and seven eggs are laid in an excavated nest near a shrub or burrow entrance between May and July (Ernst and Lovich 2009). Hatching occurs 90 to 120 days later, depending on environmental conditions, especially temperature. Eggs and young are unattended by the parents. Hatchlings develop into females when the incubation (i.e., soil) temperature is greater than 89.3 degrees Fahrenheit (°F) and males when the temperature is below that (Spotila et al. 1994). Egg hatch rates vary, but hatchling, and juvenile mortalities are assumed to be very high. It has been estimated that only one hatchling for every 15 to 20 nests will survive to reach sexual maturity. The average age of reproductive viability of females primarily is a function of individual size, but it usually is between the ages of 12 and 25 years (USFWS 1994). Females from the Mojave population produce from one to three clutches of eggs staggered throughout the reproductive season (Turner et al. 1986).

The desert tortoise is normally an obligate herbivore, subsisting largely on various annual and perennial forbs, grasses, cacti, and other non-woody plants (Ernst and Lovich 2009). A study of desert tortoise food habits in the Mojave Desert found that they will consume at least 43 plant species, including 37 annuals and 6 perennials. The diet showed a very strong preference for native plants (95 percent), and some of their preferred food plants were uncommon to rare (Jennings 1997). The most important food items seem to be desert annuals, plants that often have a life span of less than 30 days, and plants that generally are available only from April to June. Preferred plants are often uncommon or rare in tortoise environments (Ernst and Lovich 2009; Jennings 1997). Tortoises are capable of eating large quantities of food when it is available; the contents of a tortoise's digestive tracts can constitute 11 to 21 percent of its total body mass (Ernst and Lovich 2009). Desert tortoises also ingest rocks, bones, and soil, possibly to maintain intestinal bacteria, to provide additional minerals, or as gastroliths (small stones) to aid digestion (Ernst and Lovich 2009; Esque and Peters 1994).

Mojave desert tortoises are primarily found in Mojave Desert scrub habitat. Typical habitat consists of creosote bush scrub vegetation characteristic of the Upper Sonoran life zones of the Mojave and Colorado deserts. Typical desert tortoise habitat extends to 5,500 feet above mean sea level where annual precipitation ranges from 2 to 8 inches, the diversity of perennial plants is relatively high, and production of ephemerals is high. Aside from typical creosote scrub habitat, Mojave desert tortoises also are associated with creosote bursage, shadscale scrub, and Joshua tree woodland vegetation communities. Some parts of their range contain abundant Joshua trees. Desert tortoises also inhabit mixed blackbrush scrub found in the northern extent of their range between 3,500 and 5,000 feet above mean sea level (NatureServe 2015).

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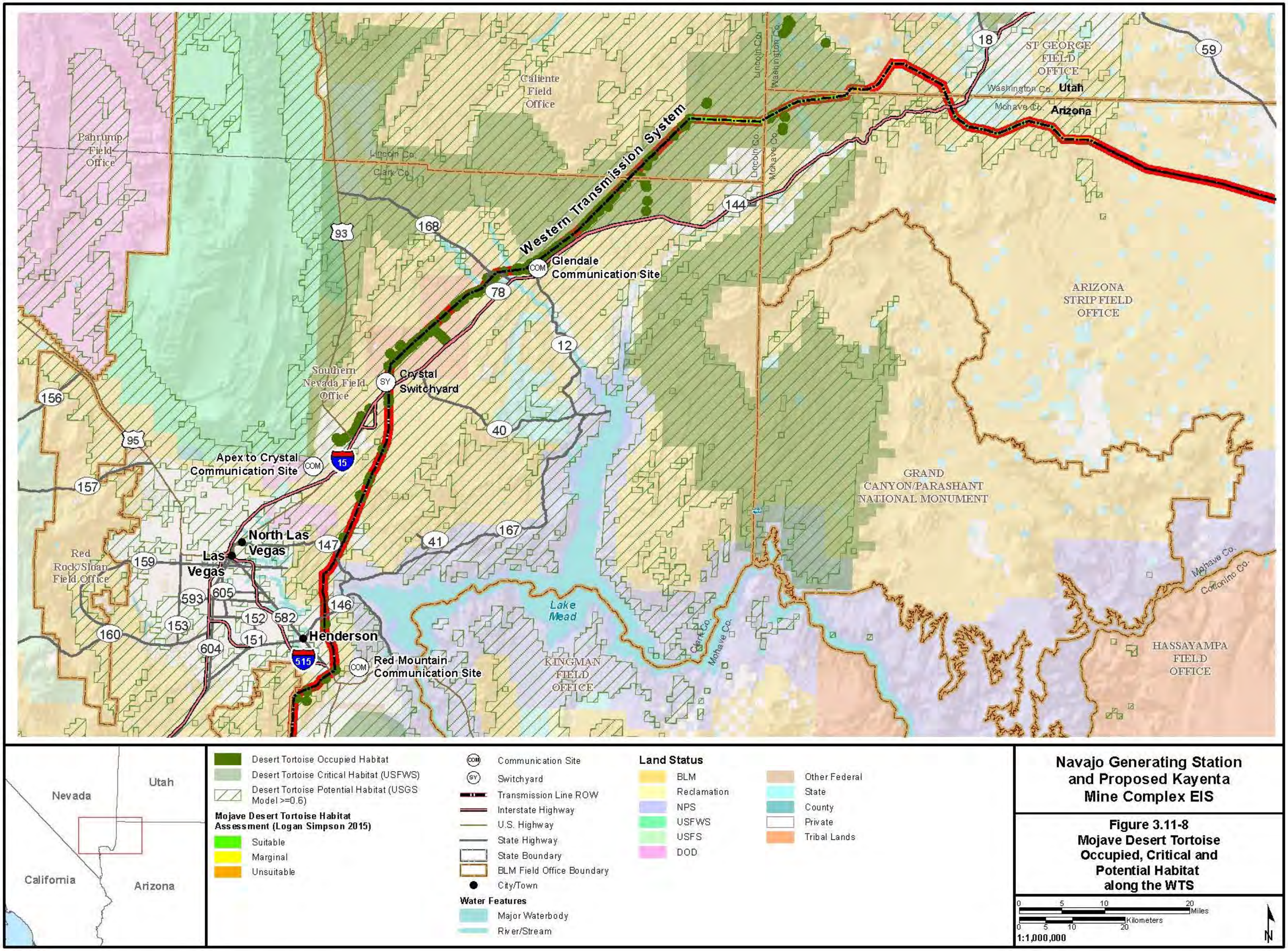

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Figure 3.11-8
Mojave Desert Tortoise Occupied, Critical and Potential Habitat along the WTS

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In the Mojave Desert, tortoises occur most commonly on gently sloping terrain with sandy-gravel soils and a sparse cover of low-growing shrubs, which allows establishment of herbaceous plants. Soils must be friable enough for the digging of burrows but firm enough so that burrows do not collapse (USFWS 2011). Tortoise burrows often are located close to washes and arroyos, especially in Mojave Desert habitats consisting of sandy loam soils covered by a more coarse surface of pebbles, cobbles, or desert pavement (Luckenbach 1982).

Of particular importance to desert tortoises is the presence of suitable burrowing substrate and vegetation that offers protective thermal cover for extreme temperatures during the summer months. Desert tortoises can spend more than 98 percent of their lives underground, especially in drought year (Ernst and Lovich 2009). Mojave desert tortoises usually will construct their own burrows to avoid extreme hot or cold temperatures that could cause life-threatening conditions for this ectothermic species. Shelters such as caliche caves or overhangs might be utilized as well. Mojave desert tortoises often excavate burrows under vegetation (such as a creosote bush, ephedra spp., or bursage), which can extend to a depth of 33 feet. Desert tortoises typically use between 12 and 25 different burrows, dens, or pallets over the course of 1 year (Ernst and Lovich 2009). Home ranges of adults tend to be larger than those of juveniles, and male home ranges of an estimated 62 acres are typically twice the size of female home ranges, although individual and seasonal variation can be considerable (O'Connor et al. 1994).

Listing and Conservation Status

The Mojave population of desert tortoise was designated as threatened in 1989 under the ESA (54 FR 32326). In 1994, a Draft Recovery Plan was issued. Critical habitat was designated in 1994, encompassing 6 million acres within six management units across California, Nevada, Utah, and Arizona (59 FR 5820). In 2011, the USFWS issued a Final Revised Recovery Plan, which reduced the number of recovery units to five and changed some boundaries of the 1994 recovery units (USFWS 2011). Since then, no significant changes in the distribution of the species have been documented, despite a decline in local populations, and no status change has been recommended (USFWS 2010).

The 2011 Final Revised Recovery Plan established five recovery units to provide for movement, dispersal, and gene flow; sufficient quantity and quality of forage species and the proper soil conditions to provide for the growth of such species; suitable substrates for burrowing, nesting, and overwintering burrows, caliche caves, and other shelter sites; sufficient vegetation for shelter from temperature extremes and predators; and habitat protected from disturbance and human-caused mortality (USFWS 2011).

The primary threats to the Mojave desert tortoise are anthropogenic in nature. Human population growth and associated urbanization of Mojave desert tortoise habitat has resulted in a suite of direct and indirect impacts to the tortoise and its habitat. Proliferation of paved and unpaved roads, introduction of non-native invasive plant species and associated changes in the frequency and severity of wildfire, and continued energy development (especially renewable energy development and associated utility corridors) have comprised the primary threats to this species in recent years (USFWS 2010). These threats continue to result in habitat loss and fragmentation, nutritional compromise, and soil erosion. Indirect impacts associated with human presence in desert tortoise habitat include illegal dumping, human subsidies for tortoise predators (e.g., common ravens), and introduction of toxins. Unauthorized use of off-highway vehicles continues to be a major source of habitat degradation for the Mojave desert tortoise (USFWS 2010).

Population density studies have been conducted for many years in several areas throughout desert tortoise range; however, inconsistencies in sampling methods, study scale, environmental conditions, and research goals make long-term population trend determinations difficult. Those data could provide a general overview of the species' range-wide status and demonstrate considerable declines at the local level, particularly in the western Mojave Desert (Corn 1994; USFWS 2011). Berry and Medica (1995), in their U.S. Geological Survey report, estimated that densities ranged from approximately 13 to 168 adult tortoises per square mile, depending on location. Berry and Medica also found a density of approximately 44 tortoises per square mile in southeastern Nevada, and most populations discussed in that report showed a downward trend (Berry and Medica 1995).

Beginning in 2001 (1999 in the Upper Virgin River recovery unit) annual range-wide monitoring was initiated. Results from the first 5 years of this program estimated a population density low of 2 to 8 tortoises per square mile for the Northeastern Mojave recovery unit and a high of 44 to 78 tortoises per square mile for the Upper Virgin River recovery unit. Because this monitoring program is designed to measure long-term population trends, the first 5 years of the program essentially serve to establish baseline densities and variability between years and between recovery units (USFWS 2006).

Factors Affecting Species

General factors affecting Mojave desert tortoise habitat within the project area include all of those identified as threats in the Listing and Conservation Status section, above, with construction of new utility corridors, proliferation of non-native plant species, and increased frequency and severity of wildfire likely being chief among them. Baseline ecological risk has not been evaluated for this species as it occurs outside of the area affected by emissions from NGS and the proposed KMC.

3.11.3.3.1.7 Sonoran Desert Tortoise

Species Occurrence

The Sonoran desert tortoise is known to occur along the southern portion of the STS from a few miles north of Black Canyon City south to the southern terminus of the line at the Westwing Substation. In May 2015, the USFWS completed an update to their Sonoran desert tortoise habitat model, which ranks habitat quality as high, medium, or low based on key habitat factors including elevation, vegetation type, and slope (USFWS 2015c). In addition, a field-based habitat assessment specific to the NGS-KMC Project was completed for the portion of the STS ROW that is located in potential Sonoran desert tortoise habitat. This habitat assessment included ground-truthing Southwest Regional Gap Analysis Project and LANDFIRE land cover data, evaluating adjacent land uses, and determining whether habitat was suitable or unsuitable based on key habitat parameters derived from a review of pertinent literature including current published information, habitat models, and geographic and land cover data. The habitat assessment covered approximately 37 miles along the southernmost portion of the STS. It found that only 5 percent of the study plots did not agree with Southwest Regional Gap Analysis Project land cover mapping and approximately 27 miles of this portion of the ROW comprise suitable Sonoran desert tortoise habitat and 10 miles contain unsuitable habitat (Logan Simpson 2015b). Refer to **Figure 3.11-9** for a map of Sonoran desert tortoise habitat, showing both the USFWS predicted habitat quality as well as the results of the Logan Simpson field-based habitat assessment, along the STS.

Life History and Habitat Association

The Sonoran desert tortoise is a long-lived species that is slow to reach sexual maturity and has a low reproductive rate. Females reach sexual maturity at approximately 15 years of age and reproductive activity is greatly influenced by levels of winter and spring precipitation. The species' breeding season generally is from July through October, and one clutch of 1 to 12 eggs (5 eggs average) is produced annually. Eggs hatch in September and October, and some hatchlings may overwinter in nests. Predation on nests and hatchlings is high in some populations (Arizona Interagency Desert Tortoise Team 2015).

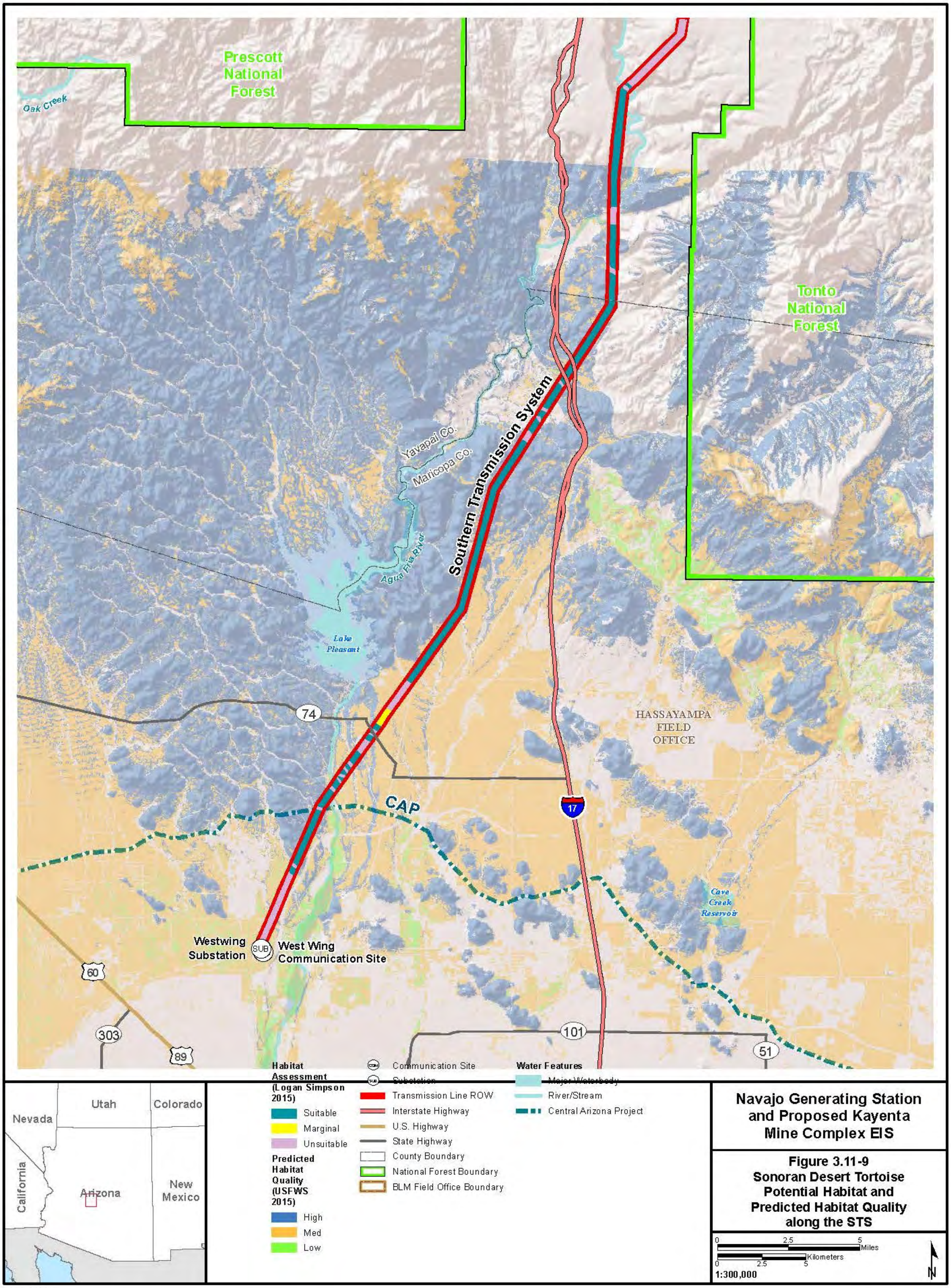

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Figure 3.11-9
Sonoran Desert Tortoise Potential Habitat and Predicted Habitat Quality along the STS

Sonoran desert tortoises primarily feed on forbs, grasses, woody plants, and succulents and are known to eat nearly 200 types of different plants. They are attracted to areas with calcium carbonate-rich soils and have been regularly observed congregating in these areas eating these soils, presumably to meet dietary mineral needs (Arizona Interagency Desert Tortoise Team 2015).

The Sonoran desert tortoise is diurnal but may emerge from shelters at night in response to rainfall. Peak activity is from late June through September, but they may be active on the surface during any month of the year. During the winter dormancy period, surface activity is dictated by thermoregulatory needs, movements between shelters, and/or the need to rehydrate during or after rainfall (Arizona Interagency Desert Tortoise Team 2015).

Home range size has been observed to vary with the size of the tortoise, habitat type, season, precipitation levels, and in response to the availability of forage plants. Observed average annual home range sizes for male tortoises have varied from approximately 23 acres to 64 acres and for female tortoises from approximately 6 acres to 58 acres (Arizona Interagency Desert Tortoise Team 2015). With the exception of dispersal movements, Sonoran desert tortoise exhibit high site fidelity to their home ranges and often focus their activities on a group of relatively closely located shelters within their home range.

Listing and Conservation Status

The USFWS established the Sonoran desert tortoise as a candidate for listing under the ESA in December 2010. On October 6, 2015, the USFWS announced the results of their 12-month finding on a petition to list the Sonoran desert tortoise as endangered or threatened under the ESA. After review of the best available scientific and commercial data, they found that listing the Sonoran desert tortoise is not warranted at this time.

In June of 2015, a candidate conservation agreement for the Sonoran desert tortoise in Arizona was executed by the Arizona Interagency Desert Tortoise Team, a consortium of federal and state agencies. The goals of the candidate conservation agreement are to provide an enforceable management strategy for desert tortoises in Arizona that will conserve existing populations of the species and be considered in the decision of whether or not to list the species in the future. Specific objectives of the candidate conservation agreement include the identification and implementation of proactive conservation measures across the range of the Sonoran desert tortoise in Arizona.

Primary anthropogenic threats to the Sonoran desert tortoise include a variety of impacts to the quality and extent of its habitat including invasion and purposeful cultivation of nonnative plant species that greatly increase the threat of wildfire in an ecosystem that evolved in the absence of wildfire, increased human population growth and associated urban development, and livestock grazing. In addition, the slow rate of recovery of desert scrub habitat following disturbance hinders the ability of remediation projects to prevent Sonoran desert tortoise population declines in the short- and medium-term (75 FR 78121).

Although illegal, collection of wild Sonoran desert tortoises for pets may be a continuing threat to this species, particularly in areas of new development that are in close proximity to tortoise habitat. A related threat is the intentional and unintentional release of captive-bred and hybrid pet desert tortoises into the wild. Such releases pose a risk of genetic contamination of wild populations, which can weaken the genetic fitness of wild tortoise populations and render them vulnerable to extirpation (75 FR 78122).

Predation by feral and off-leash dogs pose a threat to the Sonoran desert tortoise and, in most cases, is strongly correlated with distance to urban areas. Predation by feral dogs has been documented in approximately half of the long-term monitoring plots in Arizona and may be a major cause of population decline in one plot (75 FR 78122).

Human depredation, or intentional killing, of Sonoran desert tortoises as a result of vandalism (most commonly by recreational target shooters) is another threat to this species. This threat is most prevalent in areas of great vehicular access and in proximity to urban areas. The effect of human depredation on Sonoran desert tortoises is not well known, but it is likely most prevalent on the more conspicuous adult size class and may act synergistically with other threats (75 FR 78122).

There is insufficient monitoring data to analyze overall population trends for the Sonoran desert tortoise, and a variety of factors make it difficult to obtain accurate population data including the tortoise's slow movement and camouflaged appearance, the complexity of its habitat (large boulders, relatively dense vegetation, and high topographic relief), and behavioral factors (75 FR 78101). In addition, the relatively short sampling period for such a long-lived species renders overall population trend analysis problematic. It is known that there have been periodic, localized, and occasionally substantial declines in at least 5 of the 17 monitored populations, but these are thought to have been random events and not indicative of population trends as a whole (75 FR 78101).

Factors Affecting Species

Factors affecting Sonoran desert tortoise habitat within the project area are the same as those described as threats in the Listing and Conservation Status section, above. Baseline ecological risk has not been evaluated for this species as it occurs outside of the area affected by emissions from NGS and the proposed KMC.

3.11.3.3.1.8 Narrow-headed Gartersnake

Species Occurrence

The Upper Verde River in the vicinity of the STS crossing has been proposed as critical habitat for the narrow-headed gartersnake (78 FR 41550-41608). Records of occurrence for the Upper Verde are as recent as 2012 (79 FR 38687). Although the population is considered likely not viable, it is assumed that the species currently is extant within the STS ROW where it crosses the Verde River. Refer to **Figure 3.11-10** for a map of narrow-headed gartersnake habitat along the STS.

Life History and Habitat Association

Narrow-headed gartersnakes may live as long as 10 years in the wild (Rosen and Schwalbe 1988, cited in: 79 FR 38685). Sexual maturity occurs at 2.5 years of age in males and at 2 years of age in females (Degenhardt et al. 1996, cited in: 79 FR 38685). There is little information on suitable temperatures for surface activity of the narrow-headed gartersnake; however, along Oak Creek in Arizona the snake has been observed to be surface active at air temperatures ranging from 52°F to 89°F and water temperatures ranging from 54°F to 72°F (Nowak 2006 cited in 79 FR 38685). On an annual basis, the narrow-headed gartersnake is surface-active generally between March and November (Nowak 2006 cited in: 79 FR 38684). There is no information on home range size for this species.

The narrow-headed gartersnake occurs at elevations ranging from approximately 2,300 to 8,000 feet above mean sea level. It is considered to be one of the most aquatic of the gartersnakes (Drummond and Garcia 1983; Rossman et al. 1996, cited in: 79 FR 38684). Accordingly, it is strongly associated with clear, rocky streams where it predominantly uses pool and riffle habitat that includes cobbles and boulders (multiple authors cited in: 79 FR 38684). Although highly aquatic, narrow-headed gartersnakes are known to use upland habitats within approximately 330 feet of aquatic habitat during the early fall and spring months, be strongly associated with boulders in the floodplain during summer months, and use upland habitat up to approximately 660 feet out of the floodplain during hibernation (Nowak 2006 cited in 79 FR 38684). Adjacent upland habitats used typically include Petran Montane Conifer Forest,

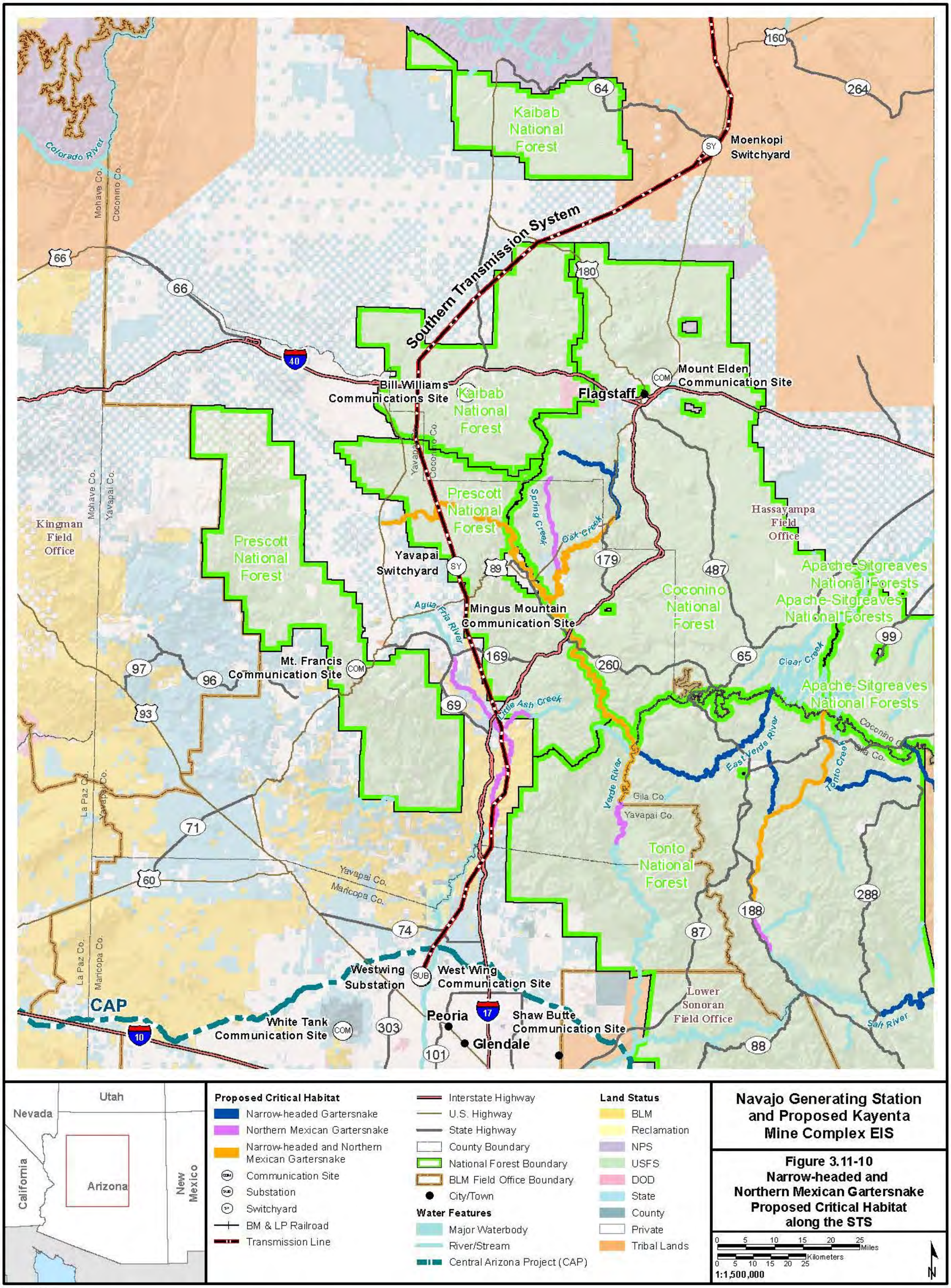

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Figure 3.11-10 Narrow-headed and Northern Mexican Gartersnake Proposed Critical Habitat along the STS

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Great Basin Conifer Woodland, Interior Chapparal, and the Arizona Upland subdivision of Sonoran Desertscrub communities (Brennan and Holycross 2006 cited in: 79 FR 38684; Rosen and Schwalbe 1988). Stream bank vegetation is an important component of suitable habitat for this species, with common associated plant species including Arizona alder, velvet ash, willows, canyon grape, blackberry, Arizona sycamore, Arizona black walnut, Fremont cottonwood, Gambel oak, and ponderosa pine (Rosen and Schwalbe 1988 cited in: 79 FR 38684).

The narrow-headed gartersnake is a predator and specializes on fish as their primary prey item (multiple authors cited in: 79 FR 38685). Native fish species including Sonora sucker, desert sucker, speckled dace, roundtail chub, Gila chub, and headwater chub are the most common prey for this gartersnake (79 FR 38685). Fingerling size classes of nonnative predatory fish also are used as prey by the narrow-headed gartersnake. Although the narrow-headed gartersnake has been reported to prey upon frogs, tadpoles, and salamanders, these are not considered important items in the diet of this species (79 FR 38685).

Native predators of the narrow-headed gartersnake include raptors, other snakes such as the regal ringneck snake, wading birds, mergansers, belted kingfishers, raccoons, and other generalist mammalian predators. Historically, Colorado pikeminnow may have preyed upon narrow-headed gartersnakes where the two species co-occurred. Native chubs also may prey on neonatal gartersnakes (79 FR 38685).

Listing and Conservation Status

The narrow-headed gartersnake was listed as a threatened species under the ESA effective August 7, 2014 (79 FR 38678). Critical habitat for this species has been proposed (78 FR 41549) but not finalized. Proposed critical habitat units occur along the STS where it crosses the Verde and Agua Fria rivers (78 FR 41550-41608).

There is no recovery plan yet in place for the narrow-headed gartersnake. Population status information indicates that the species has experienced considerable declines in population density and distribution along streams and rivers where it was formerly documented and regularly detected. As of 2004-2005, narrow-headed gartersnakes were detected in only 5 of 16 historical localities in Arizona and New Mexico (Holycross et al. 2006 as cited in: 79 FR 38678). As of 2011, the only remaining site in Arizona where the species could reliably be found was Oak Creek Canyon (79 FR 38686).

Similar to the northern Mexican gartersnake, the primary threat to the survival and recovery of the narrow-headed gartersnake is the presence of harmful nonnative species that directly prey upon them and compete with them for prey. Secondary threats are largely the same as those listed below for the northern Mexican gartersnake.

Factors Affecting Species

Factors affecting the narrow-headed gartersnake and its habitat within the project area are likely the same as those listed as threats in the Listing and Conservation Status section, above. The primary factor is the presence of harmful nonnative species. The influence of other factors likely varies by location, with relatively few factors affecting narrow-headed gartersnake proposed critical habitat at the Verde River crossing and a greater number of factors affecting potential habitat at the Agua Fria River crossings, which are in closer proximity to development and therefore at greater risk of direct and indirect impacts from recreation within riparian corridors; livestock grazing; adverse human interactions; road construction, use, and maintenance; wildfires; and environmental contaminants. Baseline ecological risk has not been evaluated for this species as it occurs outside of the area affected by emissions from NGS and the proposed KMC.

3.11.3.3.1.9 Northern Mexican Gartersnake

Species Occurrence

The only known occurrences of the northern Mexican gartersnake in the project area includes one record from the upper Verde River near where it is crossed by the STS and four records from the Agua Fria River, three of which are in the immediate vicinity of the transmission line crossings. These portions of the Verde and Agua Fria rivers have been proposed as critical habitat for the species (FR 78 41550-41608). The population occurring along the upper and middle Verde River is one of only five known populations in Arizona where the species is considered viable, and there are recent (2012) observations of the species (79 FR 38681). The most recent observation of northern Mexican gartersnakes along the Agua Fria River is from 1986, and the Agua Fria population is considered likely not viable (79 FR 38682). Refer to **Figure 3.11-10** for a map of northern Mexican gartersnake habitat along the STS.

Life History and Habitat Association

There is no information on the longevity of the northern Mexican gartersnake, but it is presumed that they may live as long as 10 years in the wild (79 FR 38678). Sexual maturity occurs at 2 years of age in males and at 2 to 3 years of age in females (79 FR 38679). The snake tends to be surface active at ambient temperatures ranging from 71°F to 91°F but spends most of its time inactive. In the northern-most portion of its range, the northern Mexican gartersnake appears to be most active from June to September, with peak activity occurring in July and August (79 FR 38679). Home range size has been documented as ranging from 1.7 acres to 10.4 acres, with a mean of 6.2 acres (Young and Boyarski 2012 cited in: 79 FR 38679).

The northern Mexican gartersnake occurs at elevations ranging from approximately 130 to 8,500 feet above mean sea level. It is a riparian obligate species, meaning that it is generally found in riparian habitats when it is not engaged in dispersal, gestation, or hibernation activities (79 FR 38678). Habitats generally suitable for this species include small, isolated wetlands such as cienegas and stock tanks; large-river riparian woodlands and forests with pools and backwaters; and streamside gallery forests (i.e., well-developed broadleaf deciduous riparian forests with limited or no herbaceous ground cover or dense grass) (multiple authors cited in: 79 FR 38679). Although considered a highly aquatic species, this snake uses terrestrial habitat for hibernation (Young and Boyarski 2012), gestation, seeking mates, and dispersal.

The northern Mexican gartersnake is a predator and forages along the banks of waterbodies where it feeds on smaller animals, including native amphibians (e.g., adult and larval leopard frogs) and fishes (e.g., desert pupfish and roundtail chub) (79 FR 38679). Additional prey items may include young Woodhouse's toads, treefrogs, earthworms, deer mice, some lizards, larval tiger salamanders, and leaches (various authors cited in: 79 FR 38678). In areas where native prey species are rare or absent, the northern Mexican gartersnake diet may comprise nonnative species including larval and juvenile bullfrogs (*Lithobates catesbeinanus*), mosquitofish (*Gambusia affinis*), or subadult green sunfish, bluegill, or largemouth bass (Emmons and Nowak 2013 cited in: 79 FR 38680).

Native predators of the northern Mexican gartersnake include raptors, other snakes, wading birds, mergansers (*Mergus merganser*), belted kingfishers (*Megaceryle alcyon*), raccoons (*Procyon lotor*), skunks (*Mephitis* spp.), and coyotes (*Canis latrans*) (Brennan et al. 2009 cited in: 79 FR 38680; Rosen and Schwalbe 1988). Historically, large predatory native fish such as the Colorado pikeminnow may have preyed upon the northern Mexican gartersnake where the two species co-occurred (79 FR 38680).

Listing and Conservation Status

The northern Mexican gartersnake was listed as a threatened species under the ESA effective August 7, 2014 (79 FR 38677). Critical habitat for this species has been proposed (78 FR 41549) but not finalized. Proposed critical habitat units occur along the STS where it crosses the Verde and Agua Fria rivers (FR 78 41550-41608).

There is no recovery plan in place for the northern Mexican gartersnake, and existing data are insufficient to determine an overall population trend for the species. Population trends at certain monitoring sites have been established and reflect considerable declines in the species with only 5 of the 29 currently known populations in the U.S. likely being viable into the foreseeable future (79 FR 38677, 38742).

The aquatic ecosystems upon which the northern Mexican gartersnake depends have been greatly degraded by the introduction and proliferation of harmful nonnative species. These species consist mainly of predatory fishes, bullfrogs, and crayfish and have been intentionally released or have dispersed into nearly every subbasin throughout the range of the northern Mexican gartersnake. The result has been widespread declines in the native fish and amphibians that comprise the primary food source for this snake and are therefore integral to its survival. These indirect impacts to the gartersnake's food source are accompanied by direct impacts to the gartersnake itself as young snakes fall prey to nonnative fishes and bullfrogs. Harmful non-native species are the most critical and pervasive threat to the survival and recovery of the northern Mexican gartersnake (79 FR 38742).

Other factors negatively affecting the northern Mexican gartersnake include amphibian decline; water management and use activities (e.g., dams, diversions, flood-control projects, and groundwater pumping); climate change; drought; development and recreation within riparian corridors; livestock grazing; adverse human interactions; road construction, use, and maintenance; high-intensity wildfires; environmental contaminants; disease and parasites; erosion control techniques; and possible competitive pressures from sympatric species (79 FR 38692-38742).

Factors Affecting Species

Factors affecting the northern Mexican gartersnake and its habitat within the project area are likely the same as those identified as threats in Listing and Conservation Status section, above. The primary factor is the presence of harmful nonnative species. The influence of other factors likely varies by location, with relatively few factors affecting proposed critical habitat for the northern Mexican gartersnake at the Verde River crossing and a greater number of factors affecting proposed critical habitat at the Agua Fria River crossings, which are in closer proximity to development and therefore at greater risk of direct and indirect impacts from recreation within riparian corridors; livestock grazing; adverse human interactions; road construction, use, and maintenance; wildfires; and environmental contaminants. Baseline ecological risk has not been evaluated for this species as it occurs outside of the area affected by emissions from NGS and the proposed KMC.

3.11.3.3.2 Other Special Status Wildlife Species

Other special status wildlife species with potential to occur along the WTS and STS and have potential to be affected by transmission line operations and maintenance activities are listed in **Table 3.11-4**.

Table 3.11-4 Other Special Status Wildlife Species Occurrence along the Transmission System ROWs

Species	Status[1]	Associated Vegetation Communities/Habitat Types[2]	WTS[3]	STS[3]
Mammals				
Desert Bighorn Sheep (*Ovis canadensis nelsoni*)	NESL G3, BLMS	Cliff and canyon, desert scrub	P	P
Pronghorn (*Antilocapra americana*)	NESL G3	Desert scrub, desert grasslands	P	K
Kit Fox (*Vulpes macrotis*)	BLMS, NESL G4	Desert scrub, desert grasslands	P	--
Northern Pocket Gopher (*Thomomys talpoides*)	FS	Desert scrub, desert grasslands, herbaceous wetland , riparian, barren/sparsely vegetated		P
Allen's Big-Eared Bat (*Idionycteris phyllotis*)	BLMS	Desert scrub, riparian, woody riparian and wetlands,	P	--
Big Free-Tailed Bat (*Nyctinomops macrotis*)	BLMS	Barren/sparsely vegetated, cliff and canyon, desert scrub, herbaceous wetland, riparian, woody riparian and wetlands, conifer woodlands.	P	--
California Leaf-Nosed Bat (*Macrotus californicus*)	BLMS	Desert scrub, riparian, woody riparian and wetlands, conifer woodlands	P	--
California Myotis (*Myotis californicus*)	BLMS	Desert scrub, herbaceous wetland, open water, riparian, , woody riparian and wetlands	P	--
Cave Myotis (*Myotis velifer*)	BLMS	Desert scrub, herbaceous wetland, open water, riparian, woody riparian and wetlands	P	--
Fringed Myotis (*Myotis thysanodes*)	BLMS	Desert scrub, herbaceous wetland, open water, riparian, woody riparian and wetlands	P	--
Greater Western Mastiff Bat (*Eumops perotis californicus*)	BLMS	Barren/sparsely vegetated, cliff and canyon, desert scrub, riparian	P	--
Little Brown Myotis (*Myotis lucifugus*)	BLMS	Barren/sparsely vegetated, cliff and canyon, desert scrub, riparian	P	--
Spotted Bat (*Euderma maculatum*)	BLMS, FS	Barren/sparsely vegetated, cliff and canyon, desert scrub, herbaceous wetland, open water, riparian, woody riparian and wetlands, conifer woodlands	K	--
Townsend's Big-eared Bat (*Corynorhinus townsendii*)	BLM, NESL G4	Desert scrub, herbaceous wetland, open water, woody riparian and wetlands, conifer woodlands	K	P

Table 3.11-4 Other Special Status Wildlife Species Occurrence along the Transmission System ROWs

Species	Status[1]	Associated Vegetation Communities/Habitat Types[2]	WTS[3]	STS[3]
Pale Townsend's Big-eared Bat (*Corynorhinus townsendii pallescens*)	BLMS, FS	Desert scrub, herbaceous wetland, open water, woody riparian and wetlands, conifer woodlands	K	--
Western Red Bat (*Lasiurus blossevillii*)	BLMS	Desert scrub, herbaceous wetland, open water, riparian, woody riparian and wetlands, conifer woodlands	P	--
Yuma Myotis (*Myotis yumanensis*)	BLMS	Barren/sparsely vegetated, cliff and canyon, desert scrub, herbaceous wetland, open water, riparian, woody riparian and wetlands	P	--
Birds				
Bald Eagle (*Haliaeetus leucocephalus*)	FS, BLMS, NESL G2, H, SGCN 1a, BGEPA	Open water, woody riparian and wetlands	K	K
Bendire's Thrasher (*Toxostoma bendirei*)	BLMS	Desert scrub	P	--
Black Swift (*Cypseloides niger*)	BLMS	Desert scrub, herbaceous wetland, open water, cliff and canyon	P	--
Bobolink (*Dolichonyx oryzivorous*)	BLMS	Desert grasslands, herbaceous wetlands	P	--
Ferruginous Hawk (*Buteo regalis*)	NESL G3, H, BLMS, SGCN 1b	Desert scrub, desert grasslands, barren/sparsely vegetated	K	K
Golden Eagle (*Aguila chrysaetos*)	NESL G3, H, BLMS, SGCN 1b, BGEPA	Desert scrub, desert grasslands, cliff and canyon, barren/sparsely vegetated, conifer woodlands	K	K
Grasshopper Sparrow (*Ammodramus savannarum*)	BLMS	Desert grasslands	P	--
LeConte's Thrasher (*Toxostoma lecontei*)	BLMS	Desert scrub, woody riparian and wetlands	P	--
Lewis's Woodpecker (*Melanerpes lewis*)	BLMS	Woody riparian and wetlands, conifer woodlands	P	--
Loggerhead Shrike (*Lanius ludovicianus*)	BLMS	Desert scrub, desert grasslands	P	--
Long-billed Curlew (*Numenius americana*)	BLMS	Desert scrub, desert grasslands, herbaceous wetlands	P	--
Northern Goshawk (*Accipiter gentilis*)	FS, BLMS, NESL G4, H, SGCN 1b	Conifer woodlands	K	K

Table 3.11-4 Other Special Status Wildlife Species Occurrence along the Transmission System ROWs

Species	Status[1]	Associated Vegetation Communities/Habitat Types[2]	WTS[3]	STS[3]
American Peregrine Falcon (*Falco peregrinus anatum*)	FS, BLMS, NESL G4, H, SGCN 1a	Cliff and canyon, desert scrub, herbaceous wetland, woody riparian and wetlands	K	K
Short-eared Owl (*Asio flammeus*)	BLMS	Desert grasslands, desert scrub, herbaceous wetlands	P	--
Snowy Plover (*Charadrius alexandrines*)	BLMS	Barren/sparsely vegetated, herbaceous wetland	P	--
Swainson's Hawk (*Buteo swainsoni*)	BLMS	Barren/sparsely vegetated, desert shrubland, desert grasslands, conifer woodlands	P	--
Western Burrowing Owl (*Athene cunicularia hypugea*)	BLMS, NESL G4, SGCN 1b	Barren/sparsely vegetated, desert shrubland, desert grasslands	K	K
Reptiles				
Common Chuckwalla (*Sauromalus ater*)	BLMS	Barren/sparsely vegetated, desert scrub	P	--
Desert Iguana (*Dipsosaurus dorsalis*)	BLMS	Barren/sparsely vegetated, desert scrub,	P	--
Desert Night Lizard (*Xantusia vigilis*)	BLMS	Barren/sparsely vegetated, cliff and canyon, desert scrub	P	--
Banded Gila Monster (*Heloderma suspectum cinctum*)	BLMS	Barren/sparsely vegetated, desert scrub	P	--
Mojave Desert Sidewinder (*Crotalus cerastes cerastes*)	BLMS	Barren/sparsely vegetated, desert scrub	P	--
Mojave Rattlesnake (*Crotalus scutulatus*)	BLMS	Desert scrub	P	--
Mojave Shovel-Nosed Snake (*Chionactis occipitalis occipitalis*)	BLMS	Barren/sparsely vegetated, desert scrub	P	--
Nevada Shovel-Nosed Snake (*Chionactis occipitalis talpina*)	BLMS	Barren/sparsely vegetated, desert scrub	P	--
Speckled rattlesnake (*Crotalus mitchellii*)	BLMS	Barren/sparsely vegetated, desert scrub	P	--
Western Banded Gecko (*Coleonyx variegatus*)	BLMS	Barren/sparsely vegetated, desert scrub	P	--
Western Threadsnake (*Leptotyphlops humilis*)	BLMS	Barren/sparsely vegetated, desert scrub, herbaceous wetland, riparian, woody riparian and wetlands	P	--

Table 3.11-4 Other Special Status Wildlife Species Occurrence along the Transmission System ROWs

Species	Status[1]	Associated Vegetation Communities/Habitat Types[2]	WTS[3]	STS[3]
Zebra-tailed lizard (*Callisaurus draconoides*)	BLMS	Barren/sparsely vegetated, desert scrub	P	--
Invertebrates				
MacNeill Sooty Wing Skipper (*Hesperopsis gracielae*)	BLMS	Herbaceous wetland, riparian, woody riparian and wetlands	P	--
Mojave Gypsum Bee (*Andrena balsamorhizae*)	BLMS	Barren/sparsely vegetated, desert scrub	P	--
Mojave Poppy Bee (*Perdita meconis*)	BLMS	Barren/sparsely vegetated, desert scrub	P	--
Northern Mojave Blue (*Euphilotes mojave virginensis*)	BLMS	Barren/sparsely vegetated, desert scrub	P	--

[1] Status: NESL = Navajo Endangered Species List, G2 = Group 2, G3 = Group 3, G4 = Group 4; H = Hopi Cultural Sensitive Species; FS = Forest Service Sensitive; BLMS = BLM Sensitive; CAS = Conservation Agreement Species; SGCN = State Species of Greatest Conservation Need, 1a = Tier 1a, 1b = Tier 1b; BGEPA = Bald and Golden Eagle Protection Act.

[2] Habitat types are based on the vegetation communities described in Section 3.8.

[3] Occurrence Categories: K = Known occurrence based on Natural Heritage Program data, Navajo data, and agency input; P = Potential occurrence based on distribution and habitat information, agency input, the USFWS IPaC system, and/or the AGFD HabiMap utility; -- = species not known to occur or not considered sensitive in that area.

The primary factors affecting other special status species along the two transmission line corridors are likely limited to existing operations and maintenance activities (particularly vegetation management actions) and the public use of transmission line access roads. Vehicle use associated with operation and maintenance of the WTS and other immediately adjacent above- and below-ground linear utilities in Lincoln and Clark counties, Nevada, along the STS, and public recreational vehicle use of access roads along these corridors can result in direct injury to and mortality of fossorial and other slow-moving special status wildlife species. Road use and maintenance activities can generate fugitive dust and introduce non-native invasive plants and noxious weeds to the transmission system ROWs and associated access routes. Fugitive dust can impact productivity of native plants and reduce their value as forage for special status wildlife species. Establishment and spread of invasive plants and noxious weeds can degrade habitat and lead to increased frequency or severity of wildfires resulting in loss and degradation of habitat for special status wildlife species. Mechanical and chemical vegetation management activities such as clearing/trimming and herbicide use also can result in habitat degradation and direct injury to special status wildlife and invertebrates depending on timing of activities and site-specific conditions. Transmission towers provide perching opportunities for raptors and ravens, which are thought by some researchers (e.g., Boarman 2002) to increase predation rates in the vicinity of transmission lines. Increased predation rates along transmission lines could affect local populations of special status small mammal and reptile species. To the extent that climate change is affecting temperatures and the frequency, timing, and/or amount of precipitation along the transmission line corridors, it is likely affecting the natural wildfire regime as well as the productivity and phenology of native plants. These factors have potential to, in turn, impact the quality and areal extent of native wildlife habitats and the special status wildlife species that depend on them.

Baseline ecological risk has not been evaluated for other special status wildlife species associated with the WTS and STS study areas. Outside of the NGS Near-field study area, species occurring along the transmission systems are not affected by NGS emissions.

3.11.4 Environmental Consequences

3.11.4.1 Issues

The following issues related to special status wildlife species were identified through public and agency scoping. Although there is overlap, issues vary somewhat by project component:

3.11.4.1.1 Navajo Generating Station

Issue 1 – Emissions and Deposition - effects of NGS emissions on special status wildlife species.

Issue 2 – Operations and Maintenance - effects of operations and maintenance of NGS and associated facilities, including the BM&LP Railroad, on special status wildlife species.

3.11.4.1.2 Proposed Kayenta Mine Complex

Issue 1 – Emissions and Deposition - effects of combined emissions from the proposed KMC and NGS on special status wildlife species within the proposed KMC study area.

Issue 2 – Operations and Reclamation - effects of mining operations and reclamation on special status wildlife species.

Issue 3 – Groundwater Pumping - effects of mine-related groundwater pumping from the N-Aquifer on associated stream and spring baseflows that support aquatic, wetland, and/or riparian habitats that may be used by special status wildlife species.

3.11.4.1.3 Transmission Systems and Communication Sites

Issue 1 – Operation and Maintenance - effects of transmission line operations and maintenance on special status wildlife species.

3.11.4.2 Assumptions and Impact Methodology

The following is a list of assumptions made and methodology uses to assess impacts of the project as they relate to special status wildlife species. The impacts identified under the separate project components below are based on correspondence with federal and state agencies, tribal representatives, and on the public scoping comments (see Section 1.11).

- Special status wildlife species and associated habitat within each of the project components was determined by:
  - Consultation and review of existing published data sources from federal and state agencies, as well as PWCC, Navajo Nation, and Hopi Tribe.
  - Identification of the types of terrestrial wildlife habitats (e.g., grasslands, forested lands, riparian areas) located within the study area using data from the vegetation analysis.
- Species was considered as having the potential to occur within the project area if:
  - Occurrence in the vicinity of one or more of the project study areas has been documented for the species; and
  - The species' current range overlaps the project area and potentially suitable habitat is present.

- There would be no construction disturbance for the NGS, BM&LP Railroad, transmission lines, and communication sites components of the project. The analysis of impacts to special status wildlife species from these components of the project is limited to the effects of operation and maintenance activities.
- Human activity, noise, and surface disturbance associated with decommissioning and reclaiming project facilities including the NGS plant, BM&LP Railroad, and proposed KMC in 2045 may result in short-term impacts on special status wildlife species and their habitats known or with potential to occur in proximity to these facilities. Following completion of these activities, it is assumed that there would be beneficial effects to special status wildlife.

3.11.4.2.1 Navajo Generating Station

- The results of the NGS Near-field ERA, Gap Regions ERA, and San Juan River ERA are used to determine the impacts of NGS emissions on special status wildlife species. Screening-level HQs based on exposure to maximum COPEC concentrations (HQ_{max}) for the 3-Unit Operation at the no adverse effects level are used to indicate potential risk to special status wildlife species. For HQ_{max} values greater than 1, the more realistic HQ value for exposure to refined COPEC concentrations is provided as an indicator of risk ($HQ_{refined}$). Refer to Section 3.0.3 for an overview of the ERAs and how they are used to evaluate the effects of NGS emissions on special status wildlife species.
- Special status wildlife habitat located within the NGS Near-field ERA, Gap Region ERA, San Juan River ERA, and proposed KMC study areas were analyzed for emission effects on wildlife habitat and representative species.
- For special status species not directly modeled in the four ERAs, analysis of modeled species with similar diets is representative of special status wildlife that occur in the analysis area.
- As detailed in the four ERAs, the risk characterization for future scenarios is conducted in the same way as the risk characterization for baseline conditions.
- As identified in the ERAs, potential exposure routes for wildlife receptors include incidental ingestion of sediment, surface water, or soil, as well as ingestion of food items containing COPECs. The actual amount of exposure by wildlife species as the result of ingestion depends on a number of factors including concentrations of COPECs in food items, size of the receptor, and bioavailability of the COPEC once consumed by the receptor.
- Known or potential occurrence of special status wildlife species were evaluated for the BM&LP Railroad in a qualitative analysis.

3.11.4.2.2 Proposed Kayenta Mine Complex

- The results of the ERA prepared for the proposed KMC study area are used to determine impacts to special status wildlife species with potential to occur in this area. Screening-level HQs based on exposure to maximum COPEC concentrations (HQ_{max}) for the 3-Unit Operation at the no adverse effects level are used to indicate potential risk to special status wildlife species. Refer to Section 3.0.2 for an overview of the ERAs and how they are used to evaluate the effects of NGS emissions on special status wildlife species.
- The known occurrence of special status wildlife species within the proposed KMC study area is based on previous National Environmental Policy Act documents, wildlife surveys, and annual monitoring reports prepared by OSMRE, PWCC, and/or PWCC contractors. Potential occurrence is based on individual species range and habitat affiliation and presence of potential habitat in the study area as documented through the vegetation analysis (Section 3.8).
- The analysis of surface water and groundwater impacts to special status wildlife species associated with riparian habitats is based on groundwater modeling presented in the water resources section (Section 3.7).

3.11.4.2.3 Transmission Systems and Communication Sites

- Known or potential occurrence of special status wildlife species were evaluated for the transmission lines and associated communication sites in a qualitative analysis.
- Operation and maintenance of communication sites would be infrequent and confined to the existing disturbance footprints of these facilities. Consequently, these activities are expected to have negligible impacts to special status wildlife species and their habitats.

3.11.4.3 Proposed Action

3.11.4.3.1 Navajo Generating Station

3.11.4.3.1.1 Federally Listed Species

California Condor

The primary activity area of the Southwest experimental non-essential population of California condor is centered 50 to 60 miles west of NGS (**Figure 3.11-1**). However, individuals occasionally fly within the vicinity of the NGS and have potential to nest in Marble Canyon, the upper portion of which is located in the NGS Near-field ERA study area. Tracked individuals also have been recorded flying east of NGS and the BM&LP Railroad. These individuals likely were on foraging flights as there don't appear to be any areas of concentrated flight activity that would suggest nesting east of Marble Canyon. Therefore, the impact issues most relevant to California condor are continued NGS operations and associated emissions.

Emissions and Deposition

The NGS Near-field ERA provided a qualitative evaluation of project risks to the California condor. As described in Section 3.11.2, Affected Environment, the condor diet primarily consists of carrion. Consequently, exposure to COPECs is expected to be via pathways similar to those evaluated for other carnivorous birds such as the red-tailed hawk. The ERA found that even maximum concentrations of COPECs resulted in HQs <1 for the red-tailed hawk. Therefore, risk to the California condor from NGS stack emissions and secondary source emissions under the Proposed Action is expected to be negligible (**Appendix 3RA**, Ecological and Human Health Risk Assessments).

Operations and Maintenance

Impacts to California condor associated with operation and maintenance of NGS and associated facilities, including the BM&LP Railroad, are not expected as occurrence of California condors in the vicinity of these facilities is infrequent and transitory. Moreover, these facilities are fenced, thereby preventing cattle and big game from occurring in the facilities and providing a source of carrion that would attract condors and render them susceptible to impacts from operation and maintenance activities. Consequently, operation and maintenance of NGS and associated facilities, including the BM&LP Railroad, under the Proposed Action would have no effect on the California condor.

Mexican Spotted Owl

As described in Section 3.11.2, Affected Environment, Mexican spotted owls have potential to occur in the NGS Near-field ERA study area (the 20-km deposition area).

Emissions and Deposition

Results of the NGS Near-field ERA indicate that operation of NGS under the Proposed Action would have no effect on the Mexican spotted owl. Under the 3-Unit Operation, the maximum HQ_{max} <1. The combination of the Proposed Action and baseline conditions also results in HQ_{max} <1. No direct or indirect impacts to Mexican spotted owl resulting from other activities associated with the operation and maintenance of NGS and associated facilities, including the BM&LP Railroad, are expected as there is no potentially suitable Mexican spotted owl nesting or roosting habitat located within 3 miles of these facilities.

Operations and Maintenance

Mexican spotted owls do not occur on the NGS plant site or along the BM&LP railroad and therefore would not be affected by other NGS operations and maintenance activities.

Southwestern Willow Flycatcher

The southwestern willow flycatcher is known to occur in riparian woodland and shrubland habitats within the NGS Near-field ERA study area and San Juan River corridor, has potential to occur in the Northeast Gap Region and, at least on a transitory basis during migration, in the Southwest Gap Region. For this reason, the southwestern willow flycatcher was evaluated in the NGS Near-field, Gap Region, and San Juan River ERAs to determine if NGS emissions under the Proposed Action would be likely to have an adverse effect on this species.

Emissions and Deposition

Results of all three NGS ERAs indicate that emissions from proposed future operations of NGS would have no effect on the southwestern willow flycatcher (HQ_{max} <1). Moreover, potential impacts to the southwestern willow flycatcher remain negligible even when combined with baseline conditions (HQ_{max} <1) (**Appendix 3RA**, Ecological and Human Health Risk Assessments; Ramboll Environ 2016a,b,c). Because the Proposed Action's only effect on southwestern willow flycatcher critical habitat along the San Juan River would be through deposition of NGS emissions, and results of the NGS San Juan River ERA indicate that the 3-Unit Operation would not result in unacceptable risk to the southwestern willow flycatcher (HQ_{max} <1), the Proposed Action would have a negligible impact on critical habitat for this species.

Operations and Maintenance

The southwestern willow flycatcher has potential to occur in riparian habitat in the Begashibito Wash/Cow Springs area adjacent to the BM&LP Railroad. Operation of the coal train under both the 3-Unit Operation and 2-Unit Operation would be a regular source of disturbance to riparian habitat in at least the lower (more southern) portions of this area. To the extent that breeding and/or migrating southwestern willow flycatchers currently use the Begashibito Wash/Cow Springs area, they are acclimated to this disturbance and train operations under either the 3-Unit Operation or 2-Unit Operation of the Proposed Action would not be expected to impact this species.

Western Yellow-billed Cuckoo

The western yellow-billed cuckoo is not known to occur within the NGS Near-field study area. It is known to occur in the San Juan River corridor, and critical habitat for the species has been proposed for portions of the river corridor containing large areas of well-developed riparian woodland vegetation. The species also has potential to occur on a transitory basis in the Southwest and the Northeast Gap Regions during migration, but the lack of riparian habitat in these areas likely render them unsuitable for breeding and nesting by this species. Due to the species potential to occur in these areas, the western yellow-billed cuckoo was evaluated in the NGS Near-field, Gap Regions, and San Juan River ERAs to determine if NGS emissions under the Proposed Action would be likely to have an adverse effect on this species.

Emissions and Deposition

Results of all three NGS ERAs indicate that maximum emissions from proposed future operations of NGS under the 3-Unit Operation would have negligible effects on the western yellow-billed cuckoo (HQ_{max} <1). Moreover, these effects would remain negligible when combined with baseline conditions (HQ_{max} <1) (**Appendix 3RA,** Ecological and Human Health Risk Assessments; Ramboll Environ 2016a,b,c). Because the Proposed Action's only affect to proposed critical habitat for the western yellow-billed cuckoo along the San Juan River would be through deposition of NGS emissions, and results of the NGS San Juan River ERA indicate that the 3-Unit Operation would not result in unacceptable risk to the western yellow-billed cuckoo (HQ_{max} <1), the Proposed Action would have a negligible impact on proposed critical habitat for this species.

Operations and Maintenance

The western yellow-billed cuckoo has been detected in riparian habitat associated with the Begashibito Wash/Cow Springs area adjacent to the BM&LP Railroad during migration. As described in Section 3.11.2, Affected Environment, this area does not appear to provide the size or stature of woody riparian vegetation necessary to support breeding and nesting cuckoos. To the extent that migrating cuckoos use this area now, operation of the coal train under both of the 3-Unit Operation and 2-Unit Operation, would not be expected to affect the cuckoo's use of the area under the Proposed Action.

3.11.4.3.1.2 Other Special Status Wildlife Species

Impacts to other special status wildlife species known or with potential to occur in the NGS Near-field, Gap Region, and San Juan River study areas are summarized in **Table 3.11-5**.

Table 3.11-5 Impacts to Other Special Status Wildlife Species Known or with Potential to Occur in the NGS ERA Study Areas under the Proposed Action

Species	Potential Impacts
Desert Bighorn Sheep	*Issue 1 – NGS Emissions/Deposition*: Desert bighorn sheep have potential to occur in the NGS Near-field study area and along the BM&LP Railroad. This species diet comprises mostly grasses and other terrestrial plants. Thus, for the purpose of determining ecological risk from NGS, the meadow vole can be considered a representative species based on similarity of diet. The NGS Near-field ERA indicates that future operation of the plant under the 3-Unit Operation would pose negligible risk to the meadow vole (HQ_{max} <1). Ecological risk to bighorn sheep would continue to be minimal when the effects of the Proposed Action are combined with baseline conditions (HQ_{max} <1). Thus, continued emissions from the plant are expected to have a negligible impact on this species. *Issue 2 – NGS Operations/Maintenance*: Due to the lack of vegetation, the high levels of human and industrial activities, and perimeter fencing around NGS, the ash disposal site, and other adjacent facilities, bighorn sheep are unlikely to occur in the immediate vicinity of NGS. Thus, future operations would have no effect on this species. Commuter vehicle and delivery truck traffic to NGS under the Proposed Action would continue to fragment and degrade bighorn sheep habitat and provide a potential source of injury/mortality in the vicinity of affected roadways. Under the 2-Unit Operation, the risk of NGS vehicle-related impact to bighorn sheep would be reduced by up to one-third relative to the 3-Unit Operation. Although desert bighorn sheep have potential to occur along a portion of the BM&LP Railroad, the railroad ROW is entirely fenced, minimizing the potential for bighorn sheep to be struck and injured or killed by the coal train. Railroad-related fragmentation of bighorn sheep habitat would continue under the Proposed Action

Table 3.11-5 Impacts to Other Special Status Wildlife Species Known or with Potential to Occur in the NGS ERA Study Areas under the Proposed Action

Species	Potential Impacts
Houserock Valley Chisel-toothed Kangaroo Rat	*Issue 1 – NGS Emissions/Deposition*: This kangaroo rat has potential to occur in the NGS Near-field study area. The species' diet consists primarily of leaves of terrestrial plants (particularly salt bush) and seeds. Because insects comprise a small portion of the species' diet, the mourning dove can be considered a representative species for assessing ecological risk from NGS emissions based on similarity of diet. The NGS Near-field ERA indicates that future operation of the plant under the 3-Unit Operation would not pose unacceptable risk to the mourning dove (HQ_{max} <1). Ecological risk to this kangaroo rat would continue to be minimal when the effects of the Proposed Action are combined with baseline conditions (HQ_{max} <1). Thus, continued emissions from the plant would have a negligible impact on this species. *Issue 2 – NGS Operations/Maintenance*: NGS-related vehicle traffic under the Proposed Action would continue to provide a potential source of injury/mortality to the Houserock Valley chisel-toothed kangaroo rat. Under the 2-Unit Operation, the level of impact associated with vehicle traffic is expected to be reduced by up to one-third relative to the 3-Unit Operation.
Bats: Spotted Bat Townsend's Big-eared Bat	*Issue 1 – NGS Emissions/Deposition*: The spotted bat and Townsend's big-eared bat have potential to occur in the vicinity of NGS and associated facilities, including the BM&LP Railroad. Using the little brown bat as representative species, future operations of NGS under the 3-Unit Operation would pose negligible risk to the little brown bat (HQ_{max} <1) and, by extension, spotted and Townsend's big-eared bats. Ecological risk to these bats would continue to be minimal when the effects of the Proposed Action are combined with baseline conditions (HQ_{max} <1). *Issue 2 – NGS Operations/Maintenance*: Future operation of the BM&LP Railroad under the 3-Unit Operation is unlikely to affect bats because these species are highly mobile and capable of avoiding collisions with the train and associated infrastructure. Based on the above, future operations of NGS and associated facilities under the Proposed Action would have negligible effects on special status bat species with potential to occur in these areas.
American Dipper	*Issue 1 – NGS Emissions/Deposition*: The American dipper is an aquatic-oriented bird that is primarily associated with fast-moving, clear, unpolluted streams with cascades, riffles, and waterfalls (Wilson and Kingery 2011). The species is therefore unlikely to occur along the main-stem Colorado or San Juan Rivers on a regular basis but may be present along streams that are tributary to these rivers. For the purposes of this Environmental Impact Statement, it is assumed that the American Dipper may occur in the NGS Near-field, Northeast Gap Region, Southwest Gap Region, and San Juan River study areas. The American Dipper primarily feeds on aquatic insects but also may take small fish and fish eggs (Wilson and Kingery 2011). For assessing ecological risk, the southwestern willow flycatcher is assumed to be representative of the American dipper. For future NGS emissions under the Proposed Action 3-Unit Operation, the maximum HQ_{max} value across all applicable study areas is less than 1. Combined with baseline conditions, the maximum HQ value across all applicable study areas remains less than 1. Thus, emissions associated with both the 3-Unit Operation and 2-Unit Operation of the Proposed Action are considered to have negligible effects on the American Dipper. *Issue 2 – NGS Operations/Maintenance*: The American dipper does not occur in the vicinity of the NGS plant or BM&LP Railroad. Thus, operation and maintenance activities proposed for these facilities would have no effect on this species.

Table 3.11-5 Impacts to Other Special Status Wildlife Species Known or with Potential to Occur in the NGS ERA Study Areas under the Proposed Action

Species	Potential Impacts
Bald Eagle	*Issue 1 – NGS Emissions/Deposition*: The bald eagle may occur in all four of the study areas used to evaluate ecological risk from NGS emissions as well as along the BM&LP Railroad. With regard to emissions impacts, the ERAs indicate that future operations of NGS under the 3-Unit Operation would result in HQ_{max} values less than 1 for all four study areas. When combined with ERA results for baseline conditions, HQ_{max} values are less than 1 for the Northeast Gap and San Juan River study areas, indicating negligible risk to bald eagles in these areas. For the NGS Near-field study area, HQ_{max} = 1 and $HQ_{refined}$ <1, indicating negligible risk to bald eagles within 20 km of the NGS facility. In contrast, in the Southwest Gap Region the HQ_{max} value for methyl mercury under the Proposed Action combined with baseline conditions is 4, with $HQ_{refined}$ = 3. Thus, future NGS emissions when combined with baseline conditions may pose risk to the bald eagle. As discussed in Section 3.11.3.1, baseline mercury levels in the Southwest Gap Region may be overestimated due to the use of questionable baseline mercury data (Ramboll Environ 2016c, Appendix A-1D). Furthermore, the Gap Region ERA assumed that bald eagles occur in the area year round when in fact they primarily spend only winter in the area (Spence 2016). Consequently, exposure duration is likely overestimated and, as a result, the potential for risk overestimated as well. Although the contribution of the Proposed Action is minimal in and of itself, when it is combined with the potentially degraded baseline conditions in the Southwest Gap Region, it may pose risk to the bald eagle. Given the uncertainty regarding the validity of baseline data and the potential overestimation of risk due to high exposure duration, impacts to the bald eagle are expected to be only minor under the Proposed Action. *Issue 2 – NGS Operations/Maintenance*: NGS-related vehicle traffic under the Proposed Action would continue to provide a potential source of injury/mortality to bald eagles feeding on roadkill in the area. Under the 2-Unit Operation, the level of impact associated with vehicle traffic is expected to be reduced by up to one-third relative to the 3-Unit Operation. Electrocution risk to bald eagles from power infrastructure at the NGS Plant site and the catenary system along the BM&LP Railroad is expected to decline as these facilities are replaced by raptor-safe designs meeting APLIC guidelines (APLIC 2012).
Other Raptors: Ferruginous Hawk Golden Eagle American Peregrine Falcon Western Burrowing Owl	*Issue 1 – NGS Emissions/Deposition*: Other special status raptors have potential to occur within the NGS Near-field study area and along the BM&LP Railroad. For the purpose of evaluating ecological risk to these species associated with baseline conditions and future operations of the NGS under the Proposed Action, the red-tailed hawk can be used as a representative species for the ferruginous hawk, golden eagle, and peregrine falcon; and the Mexican spotted owl can be used as a representative species for the burrowing owl. For the red-tailed hawk under the Proposed Action 3-Unit Operation, HQ_{max} <1. Even when combined with baseline conditions, HQ_{max} <1. Consequently, emissions associated with future operations of NGS under the Proposed Action would pose negligible risk to the ferruginous hawk, golden eagle, and American peregrine falcon. Similarly, the Proposed Action is expected to pose negligible risk to the Mexican spotted owl on its own (HQ_{max} <1) and when combined with baseline ecological risk (HQ_{max} <1). Thus, emissions associated with future operations of NGS under the Proposed Action 3-Unit Operation and 2-Unit Operation are expected to have negligible effects on the Western burrowing owl. *Issue 2 – NGS Operations/Maintenance*: Electrocution risk to other special status raptors from power infrastructure at the NGS Plant site and the catenary system along the BM&LP Railroad is expected to decline as these facilities are replaced by raptor-safe designs meeting APLIC guidelines (APLIC 2012).

3.11.4.3.1.3 Decommissioning and Abandonment

Under the Proposed Action, the majority of the operating and support facilities at the plant site would be dismantled and demolished to ground level by December 22, 2045, unless the Navajo Nation elects to continue NGS operations beyond 2044. Most of the 3,724 acres comprising the plant site and coal ash landfill would be capped, contoured, and revegetated. **Appendix 1B** provides an overview of the decommissioning process. Following decommissioning of the plant site, several buildings and other facilities would remain for use by the Navajo Nation and fences around the site and along the railroad would be left in place. Decommissioning of the BM&LP Railroad would involve removal of rails, ties, and overhead power lines. Railbed embankments would be abandoned in place and revegetated.

It is estimated that herb-dominated habitats such as grasslands would take a minimum of 2 to 5 years to establish adequate ground cover to prevent erosion and provide forage for wildlife species. Woody habitats like sagebrush shrublands would require at least 10 to 25 years for shrubs to recolonize the area.

Although there would be short-term impacts to wildlife associated with increased levels of noise and activity associated with these efforts, decommissioning of the NGS plant site and BM&LP Railroad is expected to re-open and restore wildlife habitat over the long term. Special status wildlife species expected to benefit from decommissioning of NGS and associated facilities include the Houserock Valley chisel-toothed kangaroo rat, ferruginous hawk, and burrowing owl. Because fences would be left in place, larger special status species such as the desert bighorn sheep would not benefit from restoration of the plant site, and the railroad ROW would remain a barrier to the movement of this species.

3.11.4.3.2 Proposed Kayenta Mine Complex

3.11.4.3.2.1 Federally Listed Species

<u>Black-footed Ferret</u>

Although Gunnison's prairie dogs have been observed within the proposed KMC, no black-footed ferrets or their sign have been observed in these areas, and the prairie dog colonies are too small to support black-footed ferrets. Even if these colonies were to grow to a size capable of supporting ferrets, there is no known source population capable of colonizing the site. Thus, operations of the proposed KMC from 2020 to 2044 would have no effect on the black-footed ferret.

<u>Mexican Spotted Owl</u>

<u>*Emissions and Deposition*</u>

The ERA completed for the proposed KMC study area resulted in a baseline HQ_{max} value of 1 for methylmercury. Whereas this HQ value would seem to indicate that baseline conditions pose some level of risk to the Mexican spotted owl, the more realistic refined (95 percent upper concentration limit) HQ value indicates that baseline emissions pose negligible risk of methylmercury contamination to this species ($HQ_{refined}$ <1). All other HQ values calculated for the Mexican spotted owl under baseline conditions were below 1, indicating that COPECs pose negligible risk to this species (**Appendix 3RA**, Ecological and Human Health Risk Assessments).

<u>*Operations and Reclamation*</u>

As described in the affected environment section, noise and disturbance can impact the quality of Mexican spotted owl habitat. Development of the N-10 Coal Resource Area under the 3-Unit Operation of the Proposed Action would result in increases in noise and other mining-related disturbance (e.g., night lighting and increased levels of human activity) that could degrade habitat quality in the Scoria Site Protected Activity Center and perhaps other adjacent Protected Activity Centers within the general habitat area depicted in **Figure 3.11-4**. In May 2015, there were two Mexican spotted owl detections within approximately 1.9 miles of coal resource area N-9 (Ecosystem Management Inc. 2016). Due to the close proximity of the two detections, they were likely of the same individual. A follow-up visit the next morning yielded no further detections of the bird(s) and a nest could not be located. The 2015 owl detections were the first since surveys re-commenced in 2011 and it was speculated that higher amounts of precipitation in recent years could be resulting in increased prey populations and, thus, increased habitat quality for Mexican spotted owls (Ecosystem Management Inc. 2016). The results of future surveys will determine whether or not owls have begun breeding in the area and may provide an indication of whether owl use of habitat around the historic PACs is more affected by prey density than it is by mine activity. Implementation of Conservation Measure AS-1 below, would avoid or minimize potential impacts to nesting Mexican spotted owls in the vicinity of active mining. Under the 2-Unit Operation, coal resource area N10 would remain undeveloped and potential impacts to owl habitat in adjacent PACs would be negligible.

AS-1: Mexican Spotted Owl

- Prior to implementing mining activities within 2 miles of suitable coniferous forest/canyon habitat, conduct protocol surveys for Mexican spotted owl.
- If Mexican spotted owls are determined to be nesting within the survey area, suspend surface disturbing activities within 0.25 mile of the PAC boundaries between March 1 and August 31.

Effectiveness: Implementation of this measure would determine whether Mexican spotted owls are nesting within the area with potential to be affected by noise from mining operations.

Groundwater Pumping

Mexican spotted owls and their primary prey are not obligate riparian or aquatic-oriented species. Thus, groundwater pumping would have no effect on this species.

Southwestern Willow Flycatcher

The southwestern willow flycatcher has potential to occur in tamarisk-dominated riparian areas along perennial waters within the proposed KMC and the N-Aquifer study area.

Emissions and Deposition

The ERA prepared for the proposed KMC indicates that emissions resulting from the combined operation of NGS and KMC from 2020 to 2044 within the KMC study area would not cause unacceptable ecological risks to southwestern willow flycatcher populations from exposure to trace metals under the 8.1 million tons per year (tpy) mining scenario (HQ_{max} <1). Moreover, this level of mining combined with baseline conditions results in an HQ_{max} <1, indicating that the emissions associated with the level of mining expected under the Proposed Action 3-Unit Operation would have negligible effects on southwestern willow flycatchers within the proposed KMC study area (**Appendix 3RA**, Ecological and Human Health Risk Assessments).

Operations and Reclamation

As summarized in **Table 3.8-11**, continued mine operations would have no impact to tamarisk-dominated riparian woodland and shrubland habitat. Moreover, PWCC currently has no plans for tamarisk removal within the proposed KMC (Dunfee 2016). Thus, future impacts to potential southwestern willow flycatcher habitat under the proposed action and its alternatives are not anticipated. However, if requested by the Bureau of Indian Affairs and Tribes, PWCC would likely partner with these entities to do tamarisk control work in the future (Dunfee 2016). This work would be conducted under separate authorization as necessary and appropriate at the time it is proposed.

Groundwater Pumping

Continued groundwater pumping to support mine operations under the Proposed Action are predicted to result in small decreases in baseflow (seaonsal low flow) in four of seven modeled creeks and washes within the N-Aquifer study area (Section 3.7, Water Resources). These mine-related baseflow reductions would range from 0.0004 cubic feet per second to 0.0027 cubic feet per second, a relative reduction of approximately 0.02 – 0.87 percent. Based on groundwater modeling, no change in spring flows would be expected in 95 of 98 non-monitored springs. One spring in each of Spring Groups D (Pasture Canyon/Tuba City/Moenkopi Wash area), F1 (Dennehotso area), and I (Tselani Valley area west of Chinle) would be expected to experience small decreases in flow as a result of mine pumping and associated drawdown of the N-Aquifer (Section 3.7). These decreased spring flows would range from 0.00003 gallons per minute to 0.0005 gallons per minute. Based on aerial photo interpretation, there does not appear to be any suitable habitat for southwestern willow flycatcher in Spring Group I. There does appear to be some potential southwestern willow flycatcher habitat associated with Pasture Canyon and Moenkopi Wash in Spring Group D and along Laguna Creek in Spring Group F1; although it appears to be limited and of marginal quality. As discussed in Section 3.8 these small reductions in flow are not expected to affect the tamarisk-dominated riparian vegetation in the area, particularly after 2020. Consequently, mine-related groundwater pumping is expected to have no effect on southwestern willow flycatchers with potential to use these habitats during migration.

Surface mining activities such as pit excavations and backfills are predicted to have localized effects on spring and seeps associated with the shallower Wepo Formation and hydraulically connected channel alluvium (Section 3.7). The anticipated flow reductions would be incremental and occur within an over-riding trend of declining springflows due to region-wide drought. Thus, associated impacts to riparian habitat supported by these springs are likely to be limited to areas adjacent to active mining sites. Although these effects could reduce the quality and extent of potential flycatcher habitat within the proposed KMC, given that the species currently is not known to occur in this area, impacts to riparian habitat adjacent to active mine sites would have no effect on the species itself.

Western Yellow-billed Cuckoo

Because the riparian habitats in and around the proposed KMC and the N-Aquifer study area are narrow, discontinuous, and dominated by tamarisk, they are unlikely to support the western yellow-billed cuckoo. Nevertheless, there is the possibility that the species could occur in these areas on a transitory basis during migration. For that reason, potential risk of continued mine operations have been evaluated in the proposed KMC ERA.

Emissions and Deposition

Results of the ERA indicate that emissions resulting from the proposed operation of the mine under the 8.1 million tpy mining scenario, combined with emissions from NGS from 2020 to 2044, would not impact the western yellow-billed cuckoo (HQ_{max} <1). Moreover, this level of mining combined with baseline conditions results in an HQ_{max} <1, indicating that the emissions associated with the level of mining expected under the Proposed Action 3-Unit Operation would have negligible effects on western yellow-billed cuckoos within the proposed KMC study area (**Appendix 3RA**, Ecological and Human Health Risk Assessments).

Operations and Reclamation

As described above for the southwestern willow flycatcher, mine operations would have no impact to riparian woodland and shrubland habitat under the Proposed Action and its alternatives. Consequently, there would be no impact to potential western yellow-billed cuckoo habitat within the proposed KMC permit area, *Groundwater Pumping*

As for the southwestern willow flycatcher, continued groundwater pumping to support mine operations under the Proposed Action are predicted to result in small decreases in flow in four of seven modeled creeks and washes within the N-Aquifer study area (Section 3.7). Predicted minor impacts to individual spring flows in the Pasture Canyon/Moenkopi Wash area, the Dennehotso area, and in the Tselani Valley area west of Chinle (Section 3.7) would not be expected to affect the western yellow-billed cuckoo because these areas do not contain riparian habitat of sufficient stature and extent to support this species. Similarly, although mine-related water use would have localized effects on shallow Wepo Formation spring flows, riparian habitats associated with these springs typically are narrow, dominated by tamarisk, and unlikely to support western yellow-billed cuckoos. Therefore, continued groundwater pumping associated with mine operations under both the 3-Unit Operation and 2-Unit Operation of the Proposed Action would not be expected to affect the western yellow-billed cuckoo.

3.11.4.3.2.2 Other Special Status Wildlife Species

Other special status wildlife species that are known or have potential to occur within the proposed KMC and the N-Aquifer study areas are listed in **Table 3.11-3**. Impacts to these species due to the proposed KMC would be similar to those described in Section 3.10.3.3, Kayenta Mine. Impacts that would occur to general vegetation communities within the proposed KMC where these bird species may breed and/or forage is found in **Table 3.10-4**. A brief summary of relevant life history information and the potential for occurrence, as well as any species specific impacts for other special status wildlife species within the study area are listed in **Table 3.11-6** below.

Locations of proposed pits for mining under the Proposed Action would be the same between the 3-Unit Operation and 2-Unit Operation except that under the 2-Unit Operation, the rate of mining would proceed more slowly and mining would not occur in the N-10 coal resource area. As shown in **Table 3.8-10**, the 3-Unit Operation would directly impact approximately 488 more acres of native vegetation/wildlife habitat than would the 2-Unit Operation.

Table 3.11-6 Impacts for Other Special Status Wildlife Species within the Proposed KMC and N-Aquifer Study Areas

Species	Potential Impacts
Bald Eagle	*Issue 1 – Proposed KMC Emissions/Deposition:* The Proposed KMC ERA indicates that emissions resulting from the operation of NGS and proposed KMC from 2020 through 2044 would not cause unacceptable ecological risks to bald eagle from exposure to trace metals (HQmax <1 for both project-related effects under the 8.1 million tpy operation and for project effects plus baseline) (**Appendix 3RA**, Ecological and Human Health Risk Assessments). *Issue 2 – Proposed KMC Operations/Reclamation:* Surface disturbance associated with mining operations would result in no impacts to open water habitat with potential to be used for foraging by bald eagles (**Table 3.8-5**). Under the 3-Unit Operation, impacts to pinyon-juniper woodlands, sagebrush shrublands, and mixed salt desert scrub habitats would comprise 4,738 acres, 456 acres, and 35 acres, respectively. Under the 2-Unit Operation, these impacts would be incrementally lower with 4,306 acres of pinyon-juniper woodland, 427 acres of sagebrush shrubland, and 8 acres of mixed salt desert scrub affected. Given the infrequency of bald eagle use of the proposed KMC lease area and the small magnitude of these habitat impacts relative to the amount of available habitat in the surrounding region, operation and reclamation activities within the proposed KMC are expected to have a negligible effect on this species.

Table 3.11-6 Impacts for Other Special Status Wildlife Species within the Proposed KMC and N-Aquifer Study Areas

Species	Potential Impacts
	Issue 3 – Proposed KMC Groundwater Pumping: Because groundwater pumping to support mine operations would not affect any fish-bearing streams, it would have negligible impact on bald eagle habitat within the proposed KMC and N-Aquifer study areas.
Ferruginous Hawk	*Issue 1 – Proposed KMC Emissions/Deposition:* The Proposed KMC ERA indicates that emissions resulting from the operation of NGS and proposed KMC from 2020 to 2044 would pose negligible ecological risks to the red-tailed hawk, a representative species for the ferruginous hawk (HQmax <1 for Proposed Action under the 8.1 million tpy operation; HQmax <1 when Proposed Action is combined with baseline ecological risk) (**Appendix 3RA**, Ecological and Human Health Risk Assessments). Thus, impacts to ferruginous hawk from project emissions within the proposed KMC study area would be negligible under the Proposed Action 3-Unit Operation and 2-Unit Operation. *Issue 2 – Proposed KMC Operations/Reclamation:* Mining operations would result in combined surface disturbance impacts to approximately 435 - 491 acres of native sagebrush shrubland and salt desert scrub habitats preferred by ferruginous hawks under the 3-Unit Operation and 2-Unit Operation, respectively (**Table 3.8-10**). Potential nesting habitat would be incrementally reduced where pinyon-juniper woodlands are removed along the edges of grassland and shrubland habitats. The small magnitude of these impacts relative to habitat available in the surrounding area and the long-term increase in suitable foraging habitat associated with reclaimed grassland vegetation indicate that impacts to potentially suitable ferruginous hawk habitat would be negligible. *Issue 3 – Proposed KMC Groundwater Pumping:* The ferruginous hawk is not associated with wetlands or riparian habitats. Thus, groundwater pumping to support mine operations under the Proposed Action would have no effect on this species.
Golden Eagle	*Issue 1 – Proposed KMC Emissions/Deposition:* Similar to the ferruginous hawk, emissions resulting from the operation of NGS and proposed KMC from 2020 to 2044 would pose negligible ecological risks to the golden eagle from exposure to trace metals (**Appendix 3RA**, Ecological and Human Health Risk Assessments). *Issue 2 – Proposed KMC Operations/Reclamation:* Mining operations would not result in surface disturbance to nesting habitat nor impact to nesting golden eagles as the species is not currently known to nest within the proposed KMC study area. Impacts to foraging habitat would be the same as those described above for the ferruginous hawk. *Issue 3 – Proposed KMC Groundwater Pumping:* The golden eagle is not closely associated with wetlands or riparian habitats. Thus, groundwater pumping to support mine operations would have no effect on this species.

Table 3.11-6 Impacts for Other Special Status Wildlife Species within the Proposed KMC and N-Aquifer Study Areas

Species	Potential Impacts
Northern Goshawk	*Issue 1 – Proposed KMC Emissions/Deposition:* To the extent that the red-tailed hawk can be considered representative of the northern goshawk, project emissions under the Proposed Action would have negligible effects on this species (refer to analysis for the ferruginous hawk, above). *Issue 2 – Proposed KMC Operations/Reclamation:* Because northern goshawks are not known to nest in the vicinity of the proposed KMC, potential habitat impacts associated with mining operations under the Proposed Action are expected to have no effect on this species. *Issue 3 – Proposed KMC Groundwater Pumping:* The northern goshawk is not associated with wetlands or riparian habitats. Thus, groundwater pumping to support mine operations would have no effect on this species.
Peregrine Falcon	*Issue 1 – Proposed KMC Emissions/Deposition:* Emission-related impacts to the peregrine falcon would be similar to those described for the ferruginous hawk above, i.e., project-related emissions under the Proposed Action would be expected to have negligible effects on the peregrine falcon. *Issue 2 – Proposed KMC Operations/Reclamation:* Because the peregrine falcon is not known to nest in the vicinity of the proposed KMC, potential habitat impacts associated with mining operations under the Proposed Action are expected to have no effect on this species. *Issue 3 – Proposed KMC Groundwater Pumping:* To the extent that the quality and extent of wetland and riparian habitat and associated birds and bats are affected by groundwater pumping, the peregrine falcon could be indirectly affected by the Proposed Action. However, given that impacts to riparian vegetation are expected to be negligible under the Proposed Action, impacts to the peregrine falcon would be negligible as well.
Western Burrowing Owl	*Issue 1 – Proposed KMC Emissions/Deposition:* For the purposes of ERA, the Mexican spotted owl can be considered a representative species for the western burrowing owl. As described above, project-related emissions under the Proposed Action pose negligible risk to the Mexican spotted owl and, by extension, the western burrowing owl (**Appendix 3RA**, Ecological and Human Health Risk Assessments). *Issue 2 – Proposed KMC Operations/Reclamation:* Under the Proposed Action 3-Unit Operation, mining activities would result in 456 acres (3.5 percent) of surface disturbance to sagebrush shrubland habitat and 35 acres (3.6 percent) of surface disturbance to desert scrub habitat with potential to support burrowing owls. Under the 2-Unit Operation, there would be approximately 427 acres (3.2 percent) and 8 acres (<1 percent) of disturbance in each of these habitats, respectively. However, because burrowing owls are not currently known to nest within the proposed KMC study area, it is likely that proposed mine operations would have no effect on this species. *Issue 3 – Proposed KMC Groundwater Pumping:* The western burrowing owl is not associated with wetlands or riparian habitats. Thus, groundwater pumping to support mine operations would have no effect on this species.

3.11.4.3.2.3 Decommissioning and Abandonment

Under the Proposed Action, no mining would occur in the proposed KMC after December 21, 2044. Facilities such as buildings, parking lots, roads, wells, and utilities that are requested to be kept by the tribes would be turned over to them. Other materials having economic value (such as structures and equipment) would be salvaged or recycled. All other materials would be disposed of using approved procedures and in accordance with applicable regulations. All sites would be re-contoured to conform to the natural landform, covered with topsoil, and revegetated, using the same post-mining techniques as those proposed for areas disturbed by mining.

The effects of mine decommissioning on special status wildlife species are expected to be beneficial over the long term. Reclamation and re-vegetation of disturbed lands would restore wildlife habitat for special status species. The first species to benefit would be those associated with herbaceous habitats, such as the western burrowing owl and ferruginous hawk. Over time, as shrubs and eventually forest cover returns to the site, other special status species such as northern goshawk and Mexican spotted owl could benefit as well.

3.11.4.3.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

Under the Proposed Action, general impacts to special status wildlife species resulting from operation and maintenance of the WTS, STS, and associated communication sites would be similar to those described for terrestrial wildlife in Section 3.10.4.3. The following section provides a more detailed assessment of potential transmission system operation and maintenance impacts to federally listed wildlife species and other special status wildlife species that are known or have potential to occur along the WTS and STS.

3.11.4.3.3.1 Federally Listed Species

<u>Black-footed Ferret</u>

In the desert Southwest, black-footed ferrets only have potential to occur where there are large colonies of Gunnison's prairie dog. The only portions of the study area where prairie dogs are known or have potential to occur are along a portion of the STS, within the proposed KMC, and portions of the surrounding N-Aquifer study area. The impact issues evaluated for this species relate to operations and maintenance activities along the STS and operations of the proposed KMC.

There are large colonies of Gunnison's prairie dog in the vicinity of Valle, Arizona. As described above, an experimental non-essential population of black-footed ferrets has been established on Espee Ranch, approximately 15 miles west of Valle (**Figure 3.11-5**). Although there is a remote possibility that ferrets from this population could colonize the STS corridor, given that the closest portion of the corridor is approximately 18 miles away from Espee Ranch, it is highly unlikely that ferrets would establish a self-sustaining population in the STS corridor during the timeframe of this project. Therefore, continued operation and maintenance of the STS are expected to have no effect on the black-footed ferret.

<u>California Condor</u>

California condors regularly fly over the WTS in traversing between nesting and foraging sites between Zion National Park, the Vermilion Cliffs, Kaibab Plateau, and Grand and Marble Canyons. To date, there has been only one known mortality of a condor from the Southwest population associated with a powerline. Between 2007 and 2013, there were no powerline-associated mortalities for this population. The size of the WTS towers and conductors make this facility highly visible. Similarly, the spacing between conductors far exceeds a condor's wingspan. Therefore, the likelihood of a condor colliding with or being electrocuted by interactions with the transmission line is very low and continued operation of the WTS would have negligible effects on the California condor. Aerial inspections of the WTS have potential to disturb condors foraging in the vicinity of the transmission line during inspections. However, aerial inspections of the WTS occur only once every 5 years and the disturbance is brief and unlikely to affect nesting condors. Thus, impacts to the California condor resulting from WTS maintenance activities are also likely to be negligible.

Mexican Spotted Owl

The Mexican spotted owl has potential to occur along both the WTS and STS. Potential nesting habitat along the WTS likely is limited to the Colorado and Paria River canyons. Due to height at which the transmission line crosses above these two rivers, combined with the relative lack of vegetation and/or the low stature of the vegetation within and adjacent to the ROW at these crossings, there is no need to clear or trim riparian vegetation in these locations. Consequently, transmission line operations and maintenance activities are expected to have no impact on spotted owls nesting in or flying through the Colorado and Paria River canyons.

The STS passes through potentially suitable Mexican spotted owl habitat where it traverses steep-slope coniferous cover in the Kaibab and Prescott National Forests. Where it crosses the Kaibab National Forest, the transmission lines come within approximately 2 miles of designated critical habitat for Mexican spotted owl. Vegetation within this portion of the ROW is cleared. Past ROW clearing and ongoing vegetation management have fragmented spotted owl habitat in the area and rendered the ROW largely unsuitable for nesting. However, large expanses of relatively undisturbed forest habitat remain in the area, including within and along the sides of canyons traversed by the STS. To the extent that owls occur in the area, they could forage along the transmission line ROW. Owls using the area during foraging activities may be affected by noise disturbance associated with O&M activities. Helicopter patrols may flush or disrupt MSO breeding or foraging activities. However, noise disturbances due to O&M activities, including helicopter patrols, would be temporary and localized, and would occur during daylight hours when owls are less likely to be foraging. Although the transmission lines would likely pose some collision risk to Mexican spotted owls, it is unknown to what extent powerline collisions have affected owls in this area in the past or would likely affect them in the future under the Proposed Action or otherwise. Because of the large size of the towers and conductors, these facilities are highly visible and probably easily avoided by foraging owls. Given the large spacing between conductors, the transmission lines pose very little electrocution risk to spotted owls. Operations and maintenance activities along the STS would have negligible impact on Mexican spotted owls and no effect on designated critical habitat for this species. Although the Bill Williams and Mt. Elden communication sites are located within the boundaries of designated critical habitat for the Mexican spotted owl, these facilities and their access roads do not contain the primary constituent elements of critical habitat for this species. Operation and maintenance activities associated with these communication sites would be confined to the existing disturbance footprints and therefore have no effect on the surrounding Mexican spotted owl critical habitat.

Southwestern Willow Flycatcher

The southwestern willow flycatcher is known to occur along both the WTS and STS, and critical habitat for this species is crossed by the WTS where it traverses the Virgin River in Washington County, Utah. Along the STS, this species is known to occur in riparian habitat associated with the Verde and Agua Fria rivers, both of which are crossed by the transmission lines. At each of these crossings, the rivers are spanned by the lines (i.e., there are no tower structures or other project facilities located in or immediately adjacent to riparian habitat associated with these waterbodies). Due to the height at which these rivers are crossed (approximately 300 feet above the Virgin River, 400 feet above the Verde River, and 100 to 200 feet above the Agua Fria River) there would be no need to clear or trim riparian vegetation at these crossings. There is potential for southwestern willow flycatchers to be disturbed by helicopters during aerial inspections of the transmission line. Such disturbances would be temporary and impacts would be avoided or minimized through implementation of Conservation Measure AS-2 described below. Therefore, transmission line operation and maintenance activities are expected to have negligible effects on the southwestern willow flycatcher.

The potential for impacts to the southwestern willow flycatcher during transmission line operations and maintenance activities would be further reduced through implementation of the following avoidance and minimization measures:

AS-2: Southwestern Willow Flycatcher

- Avoid ground work disturbance in the floodplain containing occupied breeding habitat between May 1 and August 30.
- For aerial patrols and inspections, transmission line operators and contractors thereof would not land the helicopter for refueling within 0.25 mile of southwestern willow flycatcher occupied habitat during the breeding season.

Effectiveness: Implementation of Conservation Measure AS-2 would avoid impacts to nesting southwestern willow flycatchers associated with ground-disturbing operation and maintenance activities and it would minimize disturbance to nesting flycatchers associated with aerial inspections of the transmission line.

<u>Western Yellow-billed Cuckoo</u>

The western yellow-billed cuckoo is known or has potential to occur along both the WTS and STS, and proposed critical habitat for this species is crossed by the STS where it crosses the Verde and Agua Fria rivers in Yavapai County, Arizona. At each of these crossings, the rivers are spanned by the lines (i.e., there are no tower structures or other project facilities located in or immediately adjacent to riparian habitat associated with these waterbodies). Due to the height at which these rivers are crossed (approximately 400 feet above the Verde River and 100 to 200 feet above the Agua Fria River), there would be no need to clear or trim riparian vegetation at the crossings. Therefore, continued operation and maintenance of the STS would not be likely to affect western yellow-billed cuckoo habitat or the species itself.

Riparian habitats associated with the Virgin River in Washington County, Utah, and with Meadow Valley Wash, Muddy River, and Las Vegas Wash in Lincoln and Clark counties, Nevada, are likely not suitable for western yellow-billed cuckoo breeding but may provide habitat for the species during migration. This is particularly true of the Virgin River as there is proposed critical habitat for the species both upstream and downstream of the WTS crossing. The Virgin River is spanned by the transmission line at a height above river bottom of over 300 feet. Therefore, there would be no need to clear or prune the tamarisk-dominated riparian vegetation in order to maintain adequate line clearances in this area. Similarly, surrounding upland vegetation is comprised of low-stature desert scrub and would require no management. Towers on either side of the river are well outside of and above the riparian zone and, based on aerial photo interpretation, there is no evidence of erosion around these structures that would lead to sedimentation of the riparian and riverine habitats below. Whereas the crossings of Meadow Valley Wash, the Muddy River, and Las Vegas Wash are closer to the river bottoms than the Virgin River crossing, aerial photos indicate that riparian vegetation management would either not be necessary in these areas or has not been conducted for some time. Given the highly disturbed nature of these three crossings and the narrowness of their riparian corridors, it is unlikely they are used by western yellow-billed cuckoo to any substantive degree. There is potential for western yellow-billed cuckoos to be disturbed by helicopters during aerial inspections of the transmission line. Such disturbances would be temporary and impacts would be avoided or minimized through implementation of Conservation Measure AS-3 described below. The lack of vegetation management, combined with the low likelihood that the species would occur in these locations indicate that continued operation and maintenance of the WTS under the Proposed Action would likely have negligible effects on the western yellow-billed cuckoo.

The potential for impacts to the western yellow-billed cuckoo during transmission systems operations and maintenance activities would be further reduced through implementation of the following avoidance and minimization measures:

AS-3: Western Yellow-billed Cuckoo

- Avoid ground work disturbance in the floodplain containing occupied breeding habitat between June 1 and August 30.
- For aerial patrols and inspections, transmission line operators and contractors thereof would not land the helicopter for refueling within 0.25 mile of yellow-billed cuckoo occupied habitat during the breeding season.

Effectiveness: Implementation of Conservation Measure AS-3 would avoid impacts to nesting western yellow-billed cuckoos associated with ground-disturbing operation and maintenance activities and it would minimize disturbance to nesting cuckoos associated with aerial inspections of the transmission line.

Mojave Desert Tortoise

The Mojave desert tortoise only occurs along the western portion of the WTS, outside of the NGS Near-field study area. Therefore, the only potential for this species to be affected by project activities would be through maintenance activities conducted within occupied and suitable habitat (**Figure 3.11-8**). Potential impacts to the Mojave desert tortoise include crushing of individuals and occupied burrows by maintenance vehicles and equipment. This species also may be impacted by short-term, localized increases in human presence and noise during maintenance events, inadvertent subsidization of tortoise predators due to trash and food scraps left on the ROW by maintenance workers, invasion and spread of noxious or invasive plant species that outcompete native plants used as forage by desert tortoises and result in increases in the frequency or severity of wildfire. Other potential impacts include inadvertent trapping of tortoises as a result of excavation and grading activities and improper handling of tortoises when they are being relocated out of harm's way.

Ground-disturbing maintenance activities within the WTS ROW generally would be limited to existing disturbed areas such as equipment pads at the bases of structures and existing access roads. Much of the WTS ROW has been previously disturbed due to past construction and maintenance activities. Consequently, operations and maintenance activities associated with the Proposed Action are expected to have minor effects on suitable habitat for Mojave desert tortoises.

Effects to designated critical habitat would be similar to those in suitable habitat. Use of access roads would not affect critical habitat, as roads and existing infrastructure, as well as localized areas of disturbance surrounding transmission towers, are excluded from critical habitat due to the lack of primary constituent elements.

A suite of Mojave desert tortoise conservation measures has been developed to avoid and minimize potential impacts to this species and its habitat associated with proposed operations and maintenance activities along the WTS. These measures and the potential impacts they address are listed under Conservation Measure RS-1, below:

RS-1 Mojave Desert Tortoise: To avoid and minimize impacts to the Mojave desert tortoise and its habitat, the WTS Operator would coordinate with Reclamation, BLM, and USFWS and, as appropriate, other federal and state land and wildlife management agencies and local government jurisdictions to implement conservation measures during operations and maintenance (including transmission infrastructure repair) activities in suitable desert tortoise habitat along the WTS. Depending on the timing (i.e., desert tortoise active vs. inactive season) and the nature and level of disturbance associated with specific operation & maintenance activities, these measures would include the following:

1. The WTS Operator would designate a company Field Contact Representative (FCR) to ensure compliance with the biological stipulations as stated in the federal ROW permits, the terms and conditions of the Biological Opinion issued for this Project, and other applicable requirements. The duties of the FCR would include the following:
   a. Complete a desert tortoise education program prior to training employees and contractors.
   b. Develop an employee and contractor environmental awareness program that would be approved by the USFWS and would cover such topics as desert tortoise distribution within the project area, general behavior and ecology, sensitivity to human activities, legal protection, penalties for violation (ESA), conservation and protection measures, reporting requirements, fire prevention, etc.
   c. Train all internal and contractor staff prior to conducting operation and maintenance activities in suitable habitat for Mojave desert tortoise.
   d. Coordinate with the USFWS regarding the approval and appropriate number of authorized biologists to be assigned on operation and maintenance activities.
   e. Maintain a training log (date and attendees) and submit this log as part of the annual reporting to Reclamation, the USFWS, BLM, and applicable state wildlife management agencies, as appropriate.
2. To limit the potential for predation of desert tortoise by ravens, the WTS Operator would implement the following measures:
   a. During any operation and maintenance activities, baseline nesting bird information would be recorded. This information would include stick nest locations, tower numbers, and notation of nesting species if possible. The operator or on-site biological monitors will conduct follow-up monitoring to determine if juvenile tortoise carcasses or bones are located under stick nests and report this information to the USFWS within 3 calendar days. This includes reporting known active raven nests (containing eggs or nestlings) so USFWS can coordinate removal. Inactive raven nests (no eggs or nestlings) may be removed at any time.
   b. To limit the potential for predation of desert tortoise by ravens, coyotes, feral dogs, and other opportunistic predators, the Operator would require all operations and maintenance waste to be contained and removed from the project area in a manner that does not attract ravens to the project area. All trash and food items would be placed in raven-proof containers and removed daily.
3. The following measures would apply to all operation and maintenance activities in Mojave desert tortoise habitat:
   a. Prior to daily operation and maintenance field activities, the Operator’s on-site supervisor would review the tortoise conservation measures with crews, log the meeting and attendees, and provide the log to the FCR at the end of the job.
   b. Project activities outside of fenced facilities would be scheduled between November 1 and February 28, as feasible.
   c. Excavations greater than 1 foot-deep would be fenced, covered, or filled at the end of each working day, or have escape ramps (1: 1 slope) provided to prevent the entrapment of wildlife. Trenches and holes would be inspected for entrapped wildlife before being filled. Any entrapped animals would be allowed to escape voluntarily before operation and

maintenance activities resume or, if necessary, they may be removed by qualified personnel with an appropriate handling permit.

d. Any pipe, culvert, or similar structure with a diameter greater than 3 inches left aboveground on the work site for one or more nights would be inspected for tortoises before the material is moved, buried, or capped. As an alternative, all structures may be capped before being stored on the site.

e. Vehicle traffic would be restricted to designated access routes and the immediate vicinity of operation and maintenance sites. Vehicle speeds would not exceed 25 mph on access and maintenance roads and 20 mph on unimproved access routes. Vehicles and equipment would be parked on pavement, existing roads, and previously disturbed areas, to the maximum extent feasible. Off-road travel in suitable habitat will be prohibited.

f. No pets (except service animals) will be permitted at work sites.

g. Prior to starting operations each day in work areas which are not totally enclosed by tortoise-proof fencing and cattle guards, the Operator's on-site Supervisor and any contract personnel would be responsible for conducting a desert tortoise inspection in coordination with the authorized desert tortoise biologist or monitor, if present (see #4 and #5, below), using techniques approved by the USFWS. The inspection would determine if any desert tortoises are present in the following locations:

   i. around and under all equipment;

   ii. in and around all routes of ingress and egress; and

   iii. in and around all other areas where the operation might expand to during that day.

   If a tortoise is discovered during this inspection or later in the day, the Operator would immediately cease all operations in the immediate vicinity of the tortoise and notify the FCR or on-site biologist, if present.

h. Desert tortoise mortalities or injuries that occur as a result of Project- or maintenance-related actions would be reported immediately to the FCR and USFWS, who would instruct operation and maintenance personnel on the appropriate action. The phone number for the FCR or USFWS point of contact would be provided to maintenance supervisors and to the appropriate agencies.

4. For operation and maintenance activities which do not result in substantial ground-disturbance, as determined by the FCR, the following measures will apply in addition to #3, above:

   a. For all non-patrol project activities occurring during the tortoise activity season (March 1 to October 31), a qualified biologist would conduct preconstruction surveys for Mojave desert tortoise in suitable habitat. The biologist would survey all work areas, including staging/laydown areas and access routes. Tortoise burrows and other sensitive features identified during the pre-construction survey would be flagged and monitored, as determined by the FCR. If tortoises are found in the work area, activities would be modified to avoid injury or harm.

   b. For all non-patrol project activities, a qualified biological monitor shall be present for all project activities occurring in designated critical habitat for Mojave desert tortoise. The biological monitor shall conduct pre-construction surveys for Mojave desert tortoise in suitable habitat. The biologist would survey all work areas, including staging/laydown areas and access routes. Tortoise burrows and other sensitive features identified during the preconstruction survey would be flagged and monitored by the biologist for avoidance.

5. For operation and maintenance activities which result in substantial ground-disturbance as determined by the FCR, the following measures would apply, in addition to #3, above:

a. An authorized desert tortoise biologist would be on-site during all ground-disturbing project activities in suitable habitat during the active desert tortoise season (March to October). At other times, a qualified biological monitor may be present in place of an authorized biologist. The biologist(s) would conduct pre-construction surveys for Mojave desert tortoise in suitable habitat. The biologist(s) would survey all work areas, including staging/laydown areas and access routes. Tortoise burrows and other sensitive features identified during the pre-construction survey shall be flagged and monitored by the biologist for avoidance.

b. Tortoises discovered to be in imminent danger during project activities may only be moved out of harm's way by an authorized desert tortoise biologist and following the terms of any concurrence or biological opinion issued by the USFWS for the work. Desert tortoises would be handled only by qualified individuals following recognized protocol (USFWS 2009, or current revisions).

c. Overnight parking and storage of equipment and materials, including stockpiling, would occur in previously-disturbed areas or areas to be disturbed that have been cleared by a qualified desert tortoise biologist. If not possible, areas for overnight parking and storage of equipment would be designated by the FCR based on recommendations of a qualified desert tortoise biologist.

d. An authorized biologist would be present for road grading activities in designated critical habitat for Mojave desert tortoise during the tortoise active season (March 1 to October 31); a qualified biologist may be present at other times of the year. The biological monitor would conduct pre-construction surveys for Mojave desert tortoise in suitable habitat. The biologist would survey all work areas, including staging/laydown areas and access routes. Tortoise burrows and other sensitive features identified during the pre-construction survey would be flagged and monitored by the biologist for avoidance.

e. Water or other substances used as dust suppressants in designated critical habitat for Mojave desert tortoise would not be allowed to pool.

6. The use of herbicides within USFWS-designated critical habitat, areas of critical environmental concern, and suitable desert tortoise habitat would be prohibited without prior approval from the USFWS and applicable land management agencies.

7. The FCR would submit annual and reports for operation and maintenance activities that result in ground disturbance or require the presence of an authorized biologist or monitor. The annual report would be submitted to Reclamation and the USFWS. Annual reports would document operation and maintenance activities that required monitors; numbers and locations of desert tortoises encountered; all instances of tortoise take resulting from harassment, harm, injury, or mortality; their disposition; effectiveness of protective measures; practicality of protective measures; recommendations for future measures that allow for better protection or more workable implementation; and the number of acres where vegetation is cleared and/or soil is disturbed. Annual reports would cover the calendar year and are due February 15 of the following year (e.g., the annual report for calendar year 2020 is due February 15, 2021).

8. Any deaths and injuries of desert tortoises would be investigated as thoroughly as possible to determine the cause. For any Mojave desert tortoise fatalities in Nevada, the wildlife staff of the USFWS Las Vegas Field Office (702-515-5230) and applicable land-managing agencies must be verbally informed of desert tortoise injuries or death immediately and within 5 business days in writing (electronic mail is sufficient). For any Mojave desert tortoise fatalities in Arizona, Law Enforcement Office (505-248-7889) and Arizona Ecological Services Office (602-242-0210) must be notified within 3 working days. The FCR or other authorized desert tortoise biologist would complete a Desert Tortoise Handling and Take Report.

9. Emergency Repairs: for emergency repairs beyond those typical operation and maintenance activities described as part of the Proposed Action, the WTS Operator would notify the local

USFWS office and appropriate federal or state land management agency within 48 hours to determine appropriate follow-up actions

Effectiveness: Implementation of the above measures would ensure that Category A and B routine maintenance activities within the permitted ROW would have only minor effects on the Mojave desert tortoise. Similarly, Category C Transmission System Activities would have minor effects on desert tortoise if the above measures are followed. However, Category C activities include actions outside of the permitted ROW and are not part of the Proposed Action. Category C actions would be permitted separately on an as-needed basis.

Sonoran Desert Tortoise

The Sonoran desert tortoise only occurs along the southern portion of the STS, outside of the NGS emissions deposition area. Therefore, the only potential for this species to be affected by Project activities would be through maintenance activities conducted within suitable habitat (**Figure 3.11-9**). Potential impacts to the Sonoran desert tortoise include crushing of individuals and occupied burrows by maintenance vehicles and equipment. This species also may be impacted by short-term, localized increases in human presence and noise during maintenance events, inadvertent subsidization of tortoise predators due to trash and food scraps left on the ROW by maintenance workers, invasion and spread of noxious or invasive plant species that outcompete native plants used as forage by desert tortoises and result in increases in the frequency or severity of wildfire. Other potential impacts include inadvertent trapping of tortoises as a result of excavation and grading activities and improper handling of tortoises when they are being relocated out of harm's way.

Ground-disturbing maintenance activities within the STS ROW generally would be limited to existing disturbed areas such as equipment pads at the bases of structures and existing access roads. Much of the STS ROW has been previously disturbed due to past construction, maintenance, and vegetation management activities. Consequently, operations and maintenance activities associated with the Proposed Action are expected to have only minor effects on suitable habitat for Sonoran desert tortoises.

A number of Sonoran desert tortoise conservation measures, collectively referred to as measure RS-2, would be implemented as part of the Proposed Action. Implementation of these measures, along with the vegetation management BMPs identified in the NGS Operation and Maintenance Plan (**Appendix 1B**), would ensure that Project-related impacts to this species and its habitat are avoided or minimized to the extent practicable. Measure RS-2 is described below.

RS-2 Sonoran Desert Tortoise: To avoid or minimize impacts to the Sonoran desert tortoise and its habitat, the Southern Transmission System Operator ("STS Operator") would coordinate with Reclamation and the AGFD, and, as appropriate, other applicable federal and state land and wildlife management agencies to implement conservation measures during transmission line operation and maintenance (including repair) activities in suitable Sonoran desert tortoise habitat along the STS. Depending on the nature and level of disturbance associated with specific operations and maintenance activities, the STS Operator would implement the following actions:

1. Designate a company FCR to assure compliance with the project Record of Decision (i.e., including these conservation measures), biological stipulations stated in the federal ROW permits, and other applicable agreements
2. Develop a training and awareness program for all operation and maintenance personnel and contractors. Training would be conducted by the FCR or a qualified contractor annually for employees conducting operations and maintenance and for contractors prior to initiating work.
3. Develop an annual refresher training program to be implemented each July, prior to the peak activity season for Sonoran desert tortoises.

4. Provide detailed instruction to all crews with regard to proper and legal tortoise handling and relocation protocols. Provide disposable gloves to minimize risk of spreading Upper Respiratory Tract Disease and other transmissible diseases from tortoise to tortoise.

5. Document all known Sonoran desert tortoise injuries and mortalities from Southern Operator's O&M activities, and record in a central database. As part of the annual training program, conduct a root cause analysis of these mortalities with recommendations from field staff to minimize.

6. Cover any holes augured for vertical structure replacement if left unattended, and inspect for trapped animals prior to filling the holes.

7. Use trained field supervisors and linemen to implement proper monitoring techniques including search for and inspection of potential burrows within work areas prior to implementing authorized repair activities, including prior to clearing of vegetation. Develop standard clearance protocol and documentation standards. FCR or qualified contractor staff would conduct field audits of clearance activities to ensure compliance and adequacy of inspections. Field audits would be conducted on 10 percent of all work conducted in high and medium value habitat as identified by the USFWS (2015b).

8. During the annual refresher training, provide all attendees a rearview mirror placard for placement in all O&M vehicles. The placard will remind workers to check under vehicles and around work areas for tortoises prior to moving vehicles.

9. Develop a database within the Southern Operator Geographic Information System, including records of Sonoran desert tortoises killed, injured, handled to move from harm's way, or detected, and tortoise shelters identified within the STS ROW during O&M activities. This database would be used by the FCR to identify hot spots and areas of special concern that may need more focused conservation awareness.

10. To reduce impacts to suitable habitat, the FCR would coordinate with the O&M project managers to minimize the work area needed repair of infrastructure or repair of unpaved access roads occurring within suitable habitat for the Sonoran desert tortoise. To the maximum extent practical and safe, repair crews would use existing disturbed areas for O&M activities. Because of the disturbance associated with initial construction of the line and ongoing routine vegetation maintenance activities, in most cases during infrastructure maintenance activities very limited vegetation clearing would be required.

Effectiveness: Implementation of the above measures would ensure that Category A and B routine maintenance activities within the permitted ROW would have only minor effects on the Sonoran desert tortoise. Similarly, Category C Transmission System Activities would have minor effects on desert tortoise if the above measures are followed; however, Category C activities would include actions outside of the permitted ROW and are not part of the Proposed Action. Category C actions would be permitted separately on an as-needed basis.

<u>Narrow-headed Gartersnake</u>

Within the analysis area, the narrow-headed gartersnake only has potential to occur along the STS where it crosses the Verde River. Because the transmission line spans the river canyon approximately 400 feet above the river itself, no vegetation management or other maintenance activities would be required in or adjacent to the river. As described in the Section 3.11.2, Affected Environment, narrow-headed gartersnakes are highly aquatic and stay within 660 feet of the floodplain throughout their life cycle (Nowak 2006). Therefore, any snakes extant along this portion of the river would likely stay within the river canyon, which is over 1,320 feet wide from rim to rim where it is crossed by the STS. Consequently, continued operation and maintenance of the STS would be expected to have negligible effects on this species and its habitat.

Northern Mexican Gartersnake

Within the analysis area, the northern Mexican gartersnake only has potential to occur along the STS where it crosses the Verde and Agua Fria rivers. Because the transmission line spans the Verde River canyon approximately 400 feet above the river bottom, no vegetation management or other maintenance activities would be required in or adjacent to the river. The STS crosses the Agua Fria River in three places and parallels the river for approximately 1 mile north of the middle crossing. The southernmost crossing is below Lake Pleasant where the river has been dewatered and no suitable gartersnake habitat is present.

At the northern and middle Agua Fria crossings, the STS spans the river canyon. The lines are approximately 100 feet above the active floodplain at the northern crossing and 200 feet above the active floodplain at the southern crossing. The portion of the line that parallels the river is located within 600 feet of the river bottom, but the towers are located on bluffs ranging from 50 to over 300 vertical feet above the active floodplain. The height of these two crossings precludes the need to manage riparian vegetation along the river bottom. Similarly, the topography along the portion of the line that parallels the river, combined with the relatively low stature of upland vegetation in this area, would prevent the need to clear or trim vegetation or perform any surface-disturbing maintenance activities that could affect northern Mexican gartersnakes during dispersal, gestation, and/or hibernation, or result in erosion and sedimentation of the riparian and riverine habitats below. Consequently, continued operation and maintenance of the STS would be expected to have negligible effects on the northern Mexican gartersnake or its habitat.

3.11.4.3.3.2 Other Special Status Species

Impacts to other special status wildlife species that are known or have potential to occur along the WTS and STS have been evaluated on a qualitative basis. These species and potential project-related impacts to them are described in **Table 3.11-7**, below. The acreages of these habitats along the WTS and STS are identified in **Tables 3.8-7** and **3.8-8**. There would be no difference between the 3-Unit Operation and 2-Unit Operation in terms of operation and maintenance along the transmission lines.

Table 3.11-7 Impacts for Other Special Status Wildlife Species known or with Potential to Occur Along the WTS and STS

Species	Potential Impacts
Mammals	
Desert Bighorn Sheep	Desert bighorn sheep have potential to occur along the WTS and the northern portion of the STS. While transmission line operations and maintenance activities have potential to displace bighorn sheep due to noise and human activity, such disturbances would be localized and temporary and would likely have no effect on this species.
Pronghorn	Pronghorn have potential to occur along the WTS and are known to occur along the STS. Transmission line operations and maintenance activities have potential to displace pronghorn due to noise and human activity. However, such disturbances would be localized and temporary and would likely have no effect on this species.
Kit Fox	Kit fox have potential to occur along the WTS. This is a nocturnal species that uses dens year-round for daytime resting, escaping predators, avoiding temperature extremes, conserving moisture, and bearing and rearing young. Transmission line operations and maintenance activities are only likely to affect kit fox if equipment drives over and collapses an occupied den. The likelihood of impacts to kit fox dens is small, particularly with implementation of the Applicant-committed worker environmental awareness program. Thus, transmission line operation and maintenance is likely to have a negligible effect on kit fox.

Table 3.11-7 Impacts for Other Special Status Wildlife Species known or with Potential to Occur Along the WTS and STS

Species	Potential Impacts
Northern Pocket Gopher	The northern pocket gopher has potential to occur along the STS where it crosses the Kaibab National Forest north-northeast of Williams, Arizona. The species is primarily fossorial (lives underground) and is most active at dawn and dusk. Like the kit fox, transmission line operations and maintenance activities could affect pocket gophers if equipment drives over and collapses an occupied burrow. Another source of impact could be the use of herbicides for vegetation management along the STS. To the extent that herbicide use reduces the abundance or palatability of roots and tubers and the occasional above-ground plant eaten by pocket gophers, it would render habitat unsuitable in affected areas. The likelihood of impacts due to herbicide use and collapsing burrows is small and the impacts would be localized and temporary. Thus, transmission line operation and maintenance would have a negligible effect on the northern pocket gopher.
Bats • Allen's big-eared bat • Big Free-tailed Bat • California Leaf-Nosed Bat • California Myotis • Cave Myotis • Fringed Myotis • Greater Western Mastiff Bat • Little Brown Myotis • Spotted Bat • Townsend's Big-eared Bat • Pale Townsend's Big-eared Bat • Western Red Bat • Yuma Myotis	As summarized in **Table 3.11-4**, several species of bats with potential to occur along the WTS are considered BLM sensitive species. Many of these species also may occur along the STS, but are not considered sensitive in the BLM Districts traversed by the STS. All of the bat species listed here are associated with desert scrub vegetation and as well as riparian, wetland, and/or open water habitats where insect prey tend to be concentrated and free water is available. Some species, such as Allen's big-eared bat, are known to roost in tree snags that could be impacted through vegetation maintenance but snag removal is only likely to be required on the STS where this species is not considered sensitive. Bats' primary prey vary somewhat by species but generally consist of moths, butterflies, dragonflies, beetles, grasshoppers, flying ants, lacewings, and mosquitoes. Transmission line operations and maintenance activities are expected to have negligible impacts to bat habitat and prey. Transmission towers provide perching habitat for raptors, such as peregrine falcons, which prey upon bats. Consequently, bat predation rates may be higher in the immediate vicinity of the WTS, particularly where it crosses wetland and riparian habitats in which bat use is concentrated, and transmission towers provide the tallest perching substrates around. However, given that the WTS has been in place for over 40 years and, for much of its length in Nevada, is co-located with other transmission lines, bat populations have likely adapted to its presence thereby minimizing potential effects of increased predation rates in the vicinity of the line. Bats are not known to collide with stationary objects such as transmission towers and conductors. Consequently, the Proposed Action is expected have negligible impacts on BLM and U.S. Forest Service-listed sensitive bats species with potential to occur along the WTS and STS.
Birds	
Raptors • American Peregrine Falcon • Bald Eagle • Ferruginous Hawk • Golden Eagle • Northern Goshawk • Short-eared Owl • Swainson's Hawk • Western Burrowing Owl	As described above, transmission lines likely to benefit raptors in open habitats along the WTS by providing substrates (towers) for nesting and perching while hunting. Forest openings maintained along the STS likely benefit raptor species, such as the Swainson's hawk, that prefer to hunt in more open grass- and shrub-dominated habitats. Conversely, they fragment habitat for forest raptors such as the northern goshawk. Transmission lines may pose some collision risk for raptors but, given the large diameter of conductors used in high-voltage lines, they are highly visible and unlikely to pose a substantial collision risk. To the extent that transmission line operations and maintenance activities are conducted during the raptor breeding season and raptors are nesting on or adjacent to the ROW, semi-annual aerial and ground inspections and/or repair activities may disturb these birds and affect nest success. Such impacts would be avoided through implementation of the transmission line operators' BMPs and mitigation measures listed above. Consequently, transmission line

Table 3.11-7 Impacts for Other Special Status Wildlife Species known or with Potential to Occur Along the WTS and STS

Species	Potential Impacts
	operations and maintenance activities are expected to have negligible effects on the other special status raptors with potential to occur along the WTS and STS.
Songbirds • Bendire's Thrasher • Black Swift • Bobolink • Grasshopper Sparrow • Le Conte's Thrasher • Lewis's Woodpecker • Loggerhead Shrike	The primary effects of the WTS and STS on the BLM-designated sensitive songbirds listed at left is likely related to the extent to which these transmission systems are used by raptors, ravens, and brood parasites such as the brown-headed cowbird for perching, nesting, and impacting songbirds through predation or brood parasitism. Such impacts are likely to be more pronounced in and adjacent to transmission line crossings of open water, wetland, and riparian habitats where songbirds tend to be more concentrated. However, given the length of time that these transmission lines have been in place, it is likely that songbirds have adjusted their behavior and nesting locations to minimize risk of predation in proximity to the transmission line. Transmission line operations and maintenance activities may affect special status songbirds if they are conducted during the breeding season and active nests are disturbed or destroyed as a result of these activities. Transmission line operators have committed to monitor for nesting birds and avoid disturbing areas with active nests until after the nesting season. Thus, operation and maintenance of the WTS and STS are expected to have negligible impacts on BLM-listed sensitive songbirds.
Shorebirds • Long-billed Curlew • Snowy Plover	BLM-listed sensitive shorebirds including the long-billed curlew and snowy plover have potential to occur in herbaceous wetlands, playas, and adjacent desert grasslands and desert scrub along the WTS. Because of the low-growing nature of the vegetation in these habitats, they would not be impacted by vegetation management activities. Periodic line inspections and ground-disturbing maintenance activities conducted during the avian breeding season would have potential to impact nesting shorebirds but these impacts would be avoided or minimized through operator-committed BMPs and mitigation measures that would avoid disturbance of active nests until after the breeding season. Both species have potential to be impacted by increased predation rates associated with raptors perching on the WTS towers and conductors.
Reptiles	
Lizards • Common Chuckwalla • Desert Iguana • Desert Night Lizard • Banded Gila Monster • Western Banded Gecko • Zebra-tailed lizard Snakes • Mojave Desert Sidewinder • Mojave Rattlesnake • Mojave Shovel-nosed Snake • Nevada Shovel-nosed Snake • Speckled rattlesnake • Western Threadsnake	BLM-listed sensitive lizards and snakes occurring along the WTS ROWs have potential to be affected by increased predation from raptors and corvids perching on transmission line infrastructure. Given the length of time that these transmission lines have been in place, reptile species prone to this predation pressure have likely shifted their habitat use away from the ROWs, thereby avoiding or minimizing their risk of predation from birds using the transmission towers and conductors as hunting perches. Operation and maintenance activities such as ground inspections and repair work have potential to impact lizards and snakes directly through the increased noise and human presence associated with these activities, crushing of individuals or their burrows by maintenance personnel and their vehicles, and/or through crushing of burrows used by small mammals that are prey to these species. Excavations associated with tower replacements or other work in the ROW could trap reptiles, cutting them off from food and cover and increasing their risk of predation. Introduction and spread of noxious weeds and other invasive plant species could degrade habitat quality and increase the frequency or severity of wildfire, leading to additional habitat degradation and loss. Fugitive dust generated by maintenance activities also could degrade habitat quality by negatively affecting the productivity and palatability of vegetation consumed by herbivorous reptiles such as desert iguana. Operation and maintenance impacts would be avoided or minimized through the implementation of operator-committed BMPs and mitigation measures including ensuring that equipment with high potential to

Table 3.11-7 Impacts for Other Special Status Wildlife Species known or with Potential to Occur Along the WTS and STS

Species	Potential Impacts
	carry weed propagules is free of soil, weeds, vegetative matter, or other debris that could harbor weed seeds prior to entering the ROW; reducing travel speeds and numbers of trips, which would minimize crushing of individuals and their burrows and minimize generation of fugitive dust; and through monitoring and covering excavation sites and maintaining wildlife escape ramps in excavated areas. Use of these measures would render impacts to BLM-sensitive reptiles along the WTS negligible.
Invertebrates	
Bees • Mojave Gypsum Bee • Mojave Poppy Bee Butterflies • MacNeill's Sooty Wing Skipper • Northern Mojave Blue or Mojave Dotted-Blue	The Mojave gypsum bee has potential to occur along the WTS in desert scrub habitat containing silverleaf sunray (*Enceliopsis argophylla*) of which the species is an obligate. The Mojave poppy bee may occur along the WTS in desert scrub habitat of the Virgin River Basin. The bee is an obligate of dwarf bear poppy, an endangered plant species (refer to Section 3.9 for more information on this bee's host plant). MacNeill's sooty wing skipper may occur along the WTS in desert washes with high water tables containing quailbush (*Atriplex lentiformis*) upon which the species deposits its eggs and which provides its larvae's only source of food. Adults require nectar-producing plants, such as heliotrope, nearby. The Mojave dotted-blue butterfly may occur along the WTS in desert scrub habitat containing plants in the genus *Eriogonum*, upon which the adults deposit their eggs and larvae feed. Transmission line operations and maintenance activities with potential to affect these invertebrates are vegetation management actions; fugitive dust generated by and introduction of noxious weeds and other invasive plants associated with use of ROW access roads by maintenance vehicles and equipment. Spread of noxious weeds and other invasive plants could, in turn, outcompete host plants and/or alter the frequency or severity wildfire in a way that results in localized loss and extirpation of host plants. Quailbush may grow to 10 feet tall. Consequently, quailbush occurring within the WTS ROW may need to be cut back on occasion in order to maintain required clearances between conductors and vegetation. However, given that quailbush with potential to support MacNeill's sooty wing skipper only occurs along washes with high water tables (such as Meadow Valley Wash in Clark County, Nevada), the transmission line is likely to span these habitats from high points on either side of the wash, thus increasing clearances and minimizing the need for trimming riparian vegetation like quailbush. Host plants associated with the other three BLM-sensitive invertebrates listed at left are low-growing and unlikely to be affected by vegetation management in the ROW. Moreover, the Mojave poppy bee's host plant is protected under the ESA and potential operation and maintenance activities affecting the plant and its pollinator would be avoided. Fugitive dust-related impacts to these species' host plants would be avoided or minimized through implementation of operator-committed BMPs including reduced speed limits along ROW access roads. Based on the above it is likely that operation and maintenance activities along the WTS would have negligible impacts on BLM-sensitive invertebrate species.

The following Applicant-committed BMPs and mitigation measures would further minimize impacts to special status wildlife associated with operation and maintenance of the WTS, STS, and/or NGS and associated facilities including the BM&LP Railroad (where applicable):

- For routine vegetation maintenance (mechanical and hand clearing) and ground-disturbing maintenance activities, workers will watch for nesting birds. If an active nest is found, the vegetation containing the active nest will be avoided until after the nesting season. If the active nest is in vegetation that is causing a safety or system reliably risk, the utility will coordinate with the USFWS and the federal land manager to determine the appropriate removal procedures and assure compliance with the MBTA.
- If raptor nests are found on system infrastructure and nest removal or repair work is necessary, the utility (i.e., Salt River Project Agricultural Improvement and Power District, Arizona Public Service Company, NV Energy) would coordinate with the USFWS and the federal land manager to assure compliance with the MBTA and Bald and Golden Eagle Protection Act, as appropriate.
- Herbicide treatments BMPs (STS only):
  - All applicable labels, federal and state laws, and regulations with regard to the use and application of herbicides will be strictly adhered to.
  - All herbicide applications will be spot treatments utilizing backpack, handheld, and quad/all-terrain vehicle mounted sprayers with plant specific treatment.
  - There will be no new roads or ground disturbing activities.
  - If a portion of the transmission line is inaccessible by road or sensitive habitats occur within the ROW, the crew will drive to the nearest location and walk to the site with the necessary equipment.
  - Between April 15 and August 15, the spray vehicle will watch for ground nesting birds. If any are seen, the operation will be stopped and the area completed utilizing handheld or backpack sprayers.
  - At any location where the vegetation density is sufficient to provide adequate cover for nest sites, for example dense stands riparian areas, the area to be treated will be surveyed by the contractor for nests prior to spraying. If nests are found during the survey or encountered during the course of the application, spraying will cease and be postponed until after August 15 or until the nest is inactive.
  - All vehicles will be operated in a safe and prudent manner during daylight hours, maintaining speeds of 15 to 20 miles per hours within the ROW.
- As transmission and lower voltage power lines are replaced and maintained, installed equipment will meet the most current Avian Power Line Interaction Committee design standards to prevent bird electrocutions.
- Speed limits would minimize vehicular collisions with wildlife and decrease fugitive dust emissions.
- Excavation sites would be monitored or covered to avoid trapping wildlife, and routes of escape for wildlife would be maintained. The construction site would be inspected daily for appropriate covering and flagging of excavation sites. Each morning the construction site would be inspected for wildlife trapped in excavation pits.
- While working in riparian areas, workers will reduce the number of trips in and out, use hand crews if possible, minimize time spent working within the riparian area, and/or stage vehicles and materials outside riparian areas, if possible.
- Biologically sensitive areas as identified by USFWS and federal land managers in the Environmental Impact Statement, Biological Assessment, and Biological Opinion will be marked or mapped prior to construction or maintenance actions, by the utility and the appropriate measures will be implemented to avoid and/or minimize impacts to known populations of threatened, endangered, or sensitive species (see species-specific measures below).

- Vegetation management on WTS and STS systems:
  - Vegetation management would not widen the ROW corridor.
  - Existing established roads would be used to access powerline ROWs.
  - Where vehicle access is not available, crews would hike in from the nearest access point.
  - Existing established roads within the powerline ROW would be used, where possible.
  - Mowers would not be operated on slopes greater than 30 percent.
- Ensure that utility mower, track or other off-road equipment, which has high potential to carry noxious weeds (not including service vehicles, pick-up trucks, passenger cars, bucket trucks, or utility vehicles/all-terrain vehicles) are free of soil, weeds, vegetative matter, or other debris that could harbor seeds prior to initiating vegetation management and treatments.
- During repairs and maintenance of project infrastructure, standard BMPs to prevent degradation of surface waters (i.e., spill prevention and capture plans, storm water runoff controls, silt fencing and straw bales, and sediment and erosion controls) would be implemented.
- Staging areas for loading and unloading of equipment will be located in previously disturbed areas, but outside of floodplains and other wet areas.
- Driving support vehicles or quad/utility terrain vehicle in riparian area will be avoided unless there is/are established road(s).

3.11.4.3.3.3 Decommissioning and Abandonment

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

3.11.4.3.4 Project Impact Summary – All Project Components

The overall effects of the Proposed Action's emissions on special status wildlife species would range from negligible to minor when considered in aggregate over the various study areas. With the exception of the bald eagle, NGS and proposed KMC emissions combined with baseline conditions would pose negligible risk to special status wildlife species within the NGS Near-field, Northeast Gap Region, Southwest Gap Region, San Juan River, and proposed KMC study areas as indicated by maximum HQs less than 1 for maximum exposure and no adverse effects levels for all species and COPEC combinations. Bald eagles in the Southwest Gap Region study area, due to seemingly elevated levels of methylmercury in their diet, are at risk of mercury toxicity under baseline conditions.

Impacts to special status wildlife species resulting from operation and maintenance of NGS and associated facilities, the proposed KMC, and the two transmission systems also would range from negligible to minor, depending on species (see species-specific summary below). Implementation of general and species-specific mitigation measures would ensure that impacts to special status wildlife resulting from mine operations and transmission line operation and maintenance activities are avoided and minimized to the extent practicable.

Mine-related groundwater pumping under the 3-Unit Operation is predicted to result in small reductions (0.0004 – 0.0027 cubic feet per second) in baseflow in four different washes and at three springs in three different spring groups (0.00003 – 0.0005 gallons per minute flow reduction) associated with the N-Aquifer. These predicted reductions in spring flows are expected to have negligible effects on riparian habitats with potential to support special status wildlife species.

The following is a summary of total project impacts to federally listed wildlife species expected under the Proposed Action:

- Black-footed Ferret – No effect: this species is not known to occur in the project area.
- California Condor – Negligible impact: NGS and associated facilities and the Kayenta Mine site currently do not provide nesting or foraging habitat for condors and NGS emissions pose negligible risk to this species. Condors are unlikely to collide with transmission infrastructure along the WTS and energized components are too widely spaced to cause a risk of electrocution. While aerial inspections of the WTS could disturb condors present along the ROW during inspections, such disturbances would be temporary and unlikely to impact the survival or reproductive potential of affected individuals.
- Mexican Spotted Owl – Minor impact: there is some potential for this species to occur in Navajo Canyon but potential habitat is located over 2 miles from the ash disposal site and, thus, plant operations would be unlikely to effect this species. NGS emissions pose negligible risk to the Mexican spotted owl as determined through the NGS Near-field ERA. Under the Proposed Action, mining in Coal Resource Areas N-10 or N-11Ext. could cause impacts to the quality and extent of Mexican spotted owl habitat in the vicinity of historic Protected Activity Centers located within 2 miles of these areas. These impacts would be minimized through implementation of Conservation Measure AS-1, which would suspend surface disturbing activities in the vicinity of the PAC boundary while Mexican spotted owls are actively nesting.
- Southwestern Willow Flycatcher – Negligible impact: there is no habitat likely to support breeding southwestern willow flycatchers within areas that would be directly or indirectly affected by operation of NGS and associated facilities and the proposed KMC. Potential migratory stopover habitat at Begashibito Wash/Cow Springs may be affected by operation of the BM&LP Railroad but, to the extent that the species is using this habitat now, it is acclimated to disturbance caused by the train and future operations of the railroad are unlikely to impact this use. Emissions associated with NGS and the proposed KMC were determined to pose negligible risk to the southwestern willow flycatcher as determined through ERA modeling. Operation and maintenance of the WTS and STS could disturb southwestern willow flycatchers nesting in the area during maintenance activities but such disturbances would be temporary and unlikely to affect habitat quality given that the transmission lines are located hundreds of feet above the riparian zone, precluding the need to clear or trim vegetation that may support nesting by this species. Implementation of Conservation Measure AS-2 would ensure that potential impacts to southwestern willow flycatcher are avoided or minimized during transmission line aerial inspections.
- Western Yellow-billed Cuckoo – Negligible impact: project-related impacts to the western yellow-billed cuckoo would be essentially identical to those summarized above for the southwestern willow flycatcher.
- Mojave Desert Tortoise – Minor impact: the Mojave desert tortoise occurs along the WTS and could be affected by maintenance activities along this ROW. Implementation of the impact avoidance and minimization measures listed under Conservation Measure RS-1 would preclude the majority of potential impacts to this species.
- Sonoran Desert Tortoise – Minor impact: the Sonoran desert tortoise occurs along the STS and could be affected by maintenance activities along this ROW. Implementation of the impact avoidance and minimization measures listed under Conservation Measure RS-2 would preclude the majority of potential impacts to this species.
- Narrow-headed Gartersnake – Negligible impact: Within the project area, potentially suitable habitat for the narrow-headed gartersnake is likely limited to the Verde and Agua Fria Rivers. These rivers are spanned by the STS at a height that precludes the need to clear or trim riparian vegetation or otherwise affect the quality of riverine, wetland, and riparian habitat capable of supporting this species. Inadvertent impacts to narrow-headed gartersnake habitat could occur from fuel or pesticide spills during vegetation management or other routine maintenance

activities along the STS, but implementation of BMPs and applicant-committed environmental protection measures would render such impacts unlikely.

- Northern Mexican Gartersnake – Negligible impact: project-related impacts to the northern Mexican gartersnake would be essentially identical to those summarized above for the narrow-headed gartersnake.

3.11.4.3.5 Cumulative Impacts

Cumulative impacts occur when the incremental effects of an action are added with the effects of other past, present, and reasonably foreseeable actions. The following text breaks down potential cumulative effects by project component and analysis issue.

3.11.4.3.5.1 Navajo Generating Station

No reasonably foreseeable future actions are anticipated at the NGS plant site that would result in cumulative impacts to special status wildlife habitat. All surface disturbances would be confined to the existing plant site and the existing railroad ROW as a continuation of operations that began in the late 1960s and 1970s. No foreseeable future tribal or federal actions would overlap these areas and result in cumulative impacts on special status wildlife species. Moreover, given that general operations of NGS and associated facilities under the Proposed Action are expected to result in negligible impacts to special status wildlife, there would be no cumulative impacts to these species associated with this alternative.

Cumulative effects associated with emissions and deposition of heavy metals and other COPECs on special status wildlife species may result when baseline conditions plus future NGS stack emissions pose a potential risk to a given species. Where this is the case, other cumulative emission sources are then evaluated to assess cumulative effects to that species. As described in previous sections, emissions from future operation of NGS under the Proposed Action would result in negligible impacts to all special status wildlife species except the bald eagle. Consequently, cumulative impacts associated with NGS emissions are evaluated only for this species.

In the Northeast Gap Region study area, the analysis of total cumulative sources (baseline + Proposed Action + other cumulative sources) resulted in an HQ_{max} = 2 for the bald eagle and methylmercury. Given that HQ_{max} for the Proposed Action was determined to be 0.003, and HQ_{max} for baseline conditions was 0.9, it is clear that other cumulative sources of methylmercury are responsible for pushing the bald eagle's total cumulative HQ_{max} value to 2 in the Northeast Gap Region. It should be noted that the total cumulative HQ value calculated for exposure to refined COPEC concentrations, a more realistic predictor of risk, was $HQ_{refined}$ = 1, indicating that bald eagles are on the cusp of being affected by methylmercury from baseline and other cumulative sources in the Northeast Gap Region. Similarly, the bald eagle appears also to be at risk of methylmercury toxicity from baseline conditions and other cumulative sources in the Southwest Gap Region. The analysis of total cumulative sources in this study area resulted in HQ_{max} = 7 and $HQ_{refined}$ = 5. The Proposed Action contributed $HQ_{refined}$ = 0.003 to this total while baseline conditions contributed $HQ_{refined}$ = 3 and other cumulative sources contributed $HQ_{refined}$ = 2. Whereas the bald eagle may be at risk of mercury toxicity in the Southwest Gap Region, it should be noted that the contribution of the Proposed Action to that risk is only 0.06 percent.

As discussed in Section 3.11.3, climate change is likely affecting special status wildlife species within the NGS Near-field, San Juan River, Northeast Gap Region, and Southwest Gap Region study areas. Climate change-related shifts in plant productivity and species composition, more extreme weather events, reduced streamflows and higher water temperatures, along with increased frequency and severity of wildfire have potential to result in direct and indirect effects to the special status wildlife species known or with potential to occur in the NGS study areas. As discussed above, NGS emissions combined with degraded baseline conditions have the potential to result in minor effects to bald eagles within the Southwest Gap Region. Cumulative impacts to bald eagles would occur when these effects combine with the effects of climate change. To the extent that climate change causes reductions in streamflow, increased water temperatures, and shifts in riparian vegetation it has potential to affect the species composition, distribution, and abundance of fish (the bald eagle's primary prey) as well as the recruitment and long-term viability of cottonwood trees, which bald eagles commonly used for perching, roosting, and nesting. Because streamflow and water temperatures in the Southwest Gap Region are and will likely continue to be more strongly influenced by Glen Canyon Dam operations than by climate change over the life of the Proposed Action, climate change-related impacts to bald eagle are likely to be negligible in this area. Streamflow and water temperatures in the Northeast Gap Region are more susceptible to ambient environmental conditions. Consequently, over the life of the Proposed Action, climate change could result in minor impacts to the bald eagle in this area.

3.11.4.3.5.2 Proposed Kayenta Mine Complex

No reasonably foreseeable future actions are anticipated that would result in cumulative impacts to special status species habitat within the proposed KMC study area. All surface disturbance would be confined within the proposed KMC lease boundary as a continuation of operations that began in the late 1960s and 1970s. No foreseeable actions would enlarge the footprint of these facilities.

As described in Section 3.7, Water Resources, groundwater pumping for mine water supplies under the Proposed Action would cause small reductions (<1%) in baseflows but these reductions are not expected to be at a level that would impact existing riparian vegetation associated with affected washes and springs. Cumulative impacts to baseflows would be more pronounced. Groundwater pumping for community water supplies is expected to result in flow reductions in seven different creeks and washes. The most pronounced reductions in baseline (2020) flow rates caused by cumulative pumping are predicted to occur in Chinle Creek (48 percent reduction), Laguna Creek (43 percent reduction), Polacca Wash (32 percent reduction), and Begashibito Wash (18 percent reduction). These flow reductions could increase moisture stress on riparian and wetland habitats, resulting in reduced extent, or less vigorous riparian communities that support riparian-dependent wildlife species, including special status wildlife species such as the southwestern willow flycatcher and western yellow-billed cuckoo, that may use these riparian areas during breeding and/or migration. Thus, the incremental reductions in baseflows under the Proposed Action, when combined with flow reductions associated with other demands on the N-Aquifer, may result in moderate to major impacts to potential habitat for these special status bird species. However, because the riparian habitats along affected washes are not currently known to support breeding southwestern willow flycatchers and western yellow-billed cuckoos, these habitat impacts are not expected to affect survival and recovery of these species. Furthermore, potential cumulative impacts to riparian vegetation would be expected to manifest slowly over many years, likely allowing any migrating southwestern willow flycatchers and western yellow-billed cuckoos that use these habitats time to shift their migratory stopover locations to other riparian habitats in the region that would not be affected by cumulative groundwater pumping.

Climate change-related effects on vegetation have potential to effect the distribution, abundance, and quality of habitat available for special status wildlife species in the proposed KMC and surrounding N-Aquifer study areas. The effects of increased temperatures and reduced or more variable precipitation could combine with project and other cumulative effects on baseflows to further impact riparian habitats potentially used by southwestern willow flycatcher and western yellow-billed cuckoo. The effects of climate change, in the form of drought, may already be responsible for degradation of Mexican spotted owl habitat in the vicinity of the proposed KMC. Ecosystem Management, Inc. (2016) hypothesized that several years of drought were responsible for loss of Douglas fir in the historic PAC north of coal resource area N-9. Death of these trees has likely degraded spotted owl habitat through effects on microclimate and loss of habitat structure. Drought may also have resulted in reduced prey densities, further degrading Mexican spotted owl habitat in the area (Ecosystem Management, Inc. 2016). To the extent that climate change is responsible for degradation of Mexican spotted owl habitat in the vicinity of the proposed KMC, these trends can be expected to continue over the life of the Proposed Action and beyond, potentially resulting in the eventual loss of suitable spotted owl habitat on Black Mesa.

3.11.4.3.5.3 Transmission Systems and Communication Sites

The reasonably foreseeable future actions that could result in cumulative impacts to special status wildlife species when combined with impacts associated with transmission line operations and maintenance activities under the Proposed Action all occur along the WTS. These actions include construction of the TransWest Express, Southern Nevada Intertie, and Eastern Nevada transmission lines, and the Lake Powell water pipeline and transmission line. The TransWest Express, Southern Nevada Intertie, and Eastern Nevada transmission lines may be constructed in the existing West-Wide Utility Corridor adjacent to the WTS from Toquop Wash (approximately 12 miles northwest of Mesquite, Nevada) to the southern terminus of the WTS in the Eldorado Valley approximately 15 miles southwest of Boulder City, Nevada (**Figure 3.0-4**). Segments of the Lake Powell water pipeline and transmission line are proposed to be constructed adjacent to the WTS through portions of Coconino and Kane counties, Arizona, and Kane County, Utah (**Figure 3.0-3**).

Potential impacts to special status wildlife from these foreseeable future actions include the following:

- Expansion of surface disturbance within the existing utility corridor that would require vegetation removal, followed by soil reapplication and revegetation. Assuming a construction ROW of 150 feet in width for transmission projects, new surface disturbance could range from 18 acres per mile for a single project to 54 acres per mile for three parallel projects.
- There would be overlapping use of existing access roads by construction and maintenance equipment for adjacent utility projects sharing the same broadly defined utility corridor.
- Authorized and unauthorized use of access roads by off-road recreational vehicles may result in surface disturbance outside the road ROW. Because of the rural setting of these transmission lines and lack of fencing or other controls, there would be potential for off-road vehicle disturbance to special status wildlife, particularly the Mojave desert tortoise, throughout the length of these transmission lines.

Any other specific proposals to construct new projects and maintain existing facilities would be coordinated through the responsible BLM or other federal and tribal land management agency offices in Nevada, Arizona, and Utah. Requirement for new roads, maintenance of existing roads, and repair of damaged roads would be developed on a project-specific basis. The net result of co-locating these facilities in a single utility corridor would be reduced requirements for new access roads, which would reduce erosion and sedimentation from the road system, reduce requirements for revegetation, and reduce habitat fragmentation for special status wildlife species relative to constructing the facilities in separate corridors.

Climate change-related impacts to vegetation and wildlife habitat could combine with Project-related and other cumulative effects to exacerbate impacts to Mojave desert tortoise over the life of the Proposed Action. Degradation of tortoise habitat quality resulting from expanded coverage of noxious weeds and other invasive plants, increased frequency and severity of wildfire, and associated losses of native plants used as forage by desert tortoises may result from climate change. These effects, combined with other cumulative impacts to tortoise habitat, could affect tortoise survival and recovery along the WTS over the next 25 years.

3.11.4.4 Natural Gas Partial Federal Replacement Alternative

This discussion is divided into two parts. The first part describes the alternative site and operational characteristics, and primary impacts to special status wildlife that have occurred, or would occur. The second part addresses the impacts to special status wildlife from reducing the power generated at NGS with consequent reductions in coal production at the Kayenta Mine.

Under the Natural Gas PFR Alternative, a selected quantity of power between 100 megawatts (MW) and 250 MW would be contracted for under a long-term power purchase agreement from currently unidentified, existing natural gas generation sources, displacing an equivalent amount of power from the federal share of NGS generation. Because the facility is assumed to currently exist, prior disturbance impacts to special status wildlife are not evaluated. Key assumptions about special status wildlife related to such an existing site are detailed below.

- A combined-cycle natural gas power plant is typically located on a site of approximately 100 acres. No additional surface disturbance would be required over time.
- Wildlife habitat has already been removed from the entire site, and will not be restored until after facility decommissioning.
- Natural gas combustion for power generation would not result in COPEC emissions and deposition that would overlap with the coal combustion emissions and deposition from NGS; therefore, there would be no deposition from natural gas combustion to wildlife habitats within any of the NGS-KMC ERA study areas. The description of emission calculations for the PFR are described in Chapter 2.0 and in Section 3.1, Air Quality.
- An existing gas plant would have been permitted by the U.S. Environmental Protection Agency to operate and would thus meet all air quality standards protective of environment including special status wildlife species.
- Because the impacts of NGS emissions under the Proposed Action 3-Unit Operation pose negligible risk to special status wildlife species and the anticipated emissions from a natural gas combined cycle plant would be a fraction of NGS emissions (see Section 3.1 Air Quality), the impacts to wildlife from emissions associated with the Natural Gas PFR Alternative would be negligible as well.

3.11.4.4.1 Navajo Generating Station

3.11.4.4.1.1 Emissions and Deposition

Under the Natural Gas PFR Alternative, NGS stack emissions of heavy metals and other COPECs would be reduced relative to the Proposed Action. For example, under the 100-MW Natural Gas PFR Alternative, there would be a 7 to 8 percent reduction in selenium, mercury, and arsenic emissions relative to the Proposed Action 2-Unit Operation and a 5 percent reduction in emissions of these metals relative to the Proposed Action 3-Unit Operation. Similarly, under the 250-MW Natural Gas PFR Alternative, there would be an 18 to 19 percent reduction in emissions of these trace metals relative to the Proposed Action 2-Unit Operation and a 12 to 13 percent reduction in emissions of selenium, mercury, and arsenic compared to the Proposed Action 3-Unit Operation. Similar reductions are assumed for other COPECs relevant to special status wildlife species.

As described in Section 3.11.4.3, NGS emissions are expected to pose negligible risk to special status wildlife species under the Proposed Action 3-Unit Operation and 2-Unit Operation. Under the 100-MW and 250-MW Natural Gas PFR Alternative, emissions and associated risks would be lower than those associated with the Proposed Action. Consequently, implementation of this alternative is expected to have no effect on special status wildlife species. Whereas plant emissions under the Natural Gas PFR Alternative would have no direct impact on special status species, when future plant emissions are combined with baseline conditions, there could be potential risk of mercury contamination to bald eagle populations within the Southwest Gap Region due to potentially elevated mercury levels associated with baseline conditions (Section 3.11.4.3).

3.11.4.4.1.2 Operations and Maintenance

Relative to the Proposed Action, there would be an incremental reduction in the amount of chemicals required by and trucked to the plant, a reduction in the amount of coal mined and transported to the plant via the BM&LP Railroad, and an associated reduction in coal combustion residuals trucked from the plant to the adjacent ash disposal site under the Natural Gas PFR Alternative. As operations and maintenance of NGS and associated facilities are expected to have negligible impacts on special status species under the Proposed Action, they would have less impact to special status wildlife species under the Natural Gas PFR Alternative.

3.11.4.4.2 Proposed Kayenta Mine Complex

3.11.4.4.2.1 Emissions and Deposition

Due to the reduction in mining and NGS power production under the 100-MW and 250-MW Natural Gas PFR alternatives there would be associated reductions in mine and plant emissions within the proposed KMC study area. As described in Section 3.11.4.3, results of the KMC ERA indicated that emissions from the mine, combined with those from NGS and baseline conditions, would pose negligible risk to special status wildlife species known or with potential to occur in the proposed KMC study area. Consequently, combined mine and plant emissions under the Natural Gas PFR Alternative are expected to have no effect on federally listed and other special status wildlife species within and adjacent to the mine permit boundary.

3.11.4.4.2.2 Operations and Reclamation

Under the Proposed Action, mining of new or expanded coal resource areas would have minor impacts to potentially suitable habitat for special status wildlife species that may occur in the proposed KMC study area. Under the 100-MW Natural Gas PFR Alternative, these impacts would be reduced by 5 and 7 percent relative to the Proposed Action 3-Unit Operation and 2-Unit Operation, respectively. Under the 250-MW Natural Gas PFR Alternative, habitat impacts would be reduced by 12 and 18 percent relative to the Proposed Action 3-Unit Operation and 2-Unit Operation, respectively. Like the Proposed Action, mine operations under the Natural Gas PFR alternatives would have a minor impact on potentially suitable habitat for special status wildlife species with potential to occur in the area. However, these impacts would be less than those expected under the Proposed Action 3-Unit Operation and 2-Unit Operation.

3.11.4.4.2.3 Groundwater Pumping

Water pumped from the N-Aquifer to support mine operations is assumed to be the same under the Natural Gas PFR Alternative as it would be under the Proposed Action. Because groundwater pumping under the Proposed Action would be expected to have negligible impacts on special status wildlife species, groundwater pumping under implementation of the 100-MW or 250-MW Natural Gas PFR Alternative also would have negligible impacts on special status wildlife.

3.11.4.4.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

Operation and maintenance of the WTS, STS, and communications sites would not change due to implementation of the Natural Gas PFR Alternative. Thus, impacts to special status wildlife species associated with operation and maintenance of the transmission systems and communication sites would be the same as the Proposed Action.

3.11.4.4.4 Project Impact Summary – All Project Components

Implementation of the either the 100-MW or the 250-MW Natural Gas PFR Alternative is expected to have negligible impacts on special status wildlife resources as a result of NGS plant and proposed KMC mine emissions. The combined new land disturbance at NGS and KMC under the Natural Gas PFR Alternative would range from a high of 5,207 acres to a low of 4,087 acres. This habitat disturbance compares to a Proposed Action range of disturbance between a high of 5,469 acres to a low of 4,940 acres, or an overall 4 to 21 percent reduction in new land disturbance for this PFR alternative.

Impacts to special status wildlife species habitat would be considered minor under this alternative because most of the native habitats affected are already degraded as a result of their proximity to active mining areas and previous testing activities and because special status species are not currently known to occur in the affected areas.

3.11.4.4.5 Cumulative Impacts

Although the degree of impact to special status wildlife species from implementation of the Natural Gas PFR Alternative are expected to be incrementally lower than those associated with the Proposed Action, cumulative impacts associated with this alternative are expected to be essentially identical to the cumulative effects described above for the Proposed Action.

3.11.4.5 Renewable Partial Federal Replacement Alternative

Under the Renewable PFR Alternative, a selected quantity of power between 100 MW and 250 MW would be contracted for under a long-term power purchase agreement from a currently unidentified, existing renewable energy power source, displacing an equivalent amount of power from the federal share of NGS generation. As the site is assumed to be an existing facility, prior disturbance impacts to special status wildlife are not evaluated.

3.11.4.5.1 Navajo Generating Station

3.11.4.5.1.1 Emissions and Deposition

Under the Renewable PFR Alternative, NGS stack emissions of heavy metals and other COPECs would be reduced relative to the Proposed Action. For example, under the 100-MW Renewable PFR Alternative, there would be a 4 percent reduction in selenium, mercury, and arsenic emissions relative to the Proposed Action 2-Unit Operation and a 3 percent reduction in emissions of these metals relative to the Proposed Action 3-Unit Operation. Similarly, under the 250-MW Renewable PFR Alternative, there would be an 11 percent reduction in emissions of these trace metals relative to the Proposed Action 2-Unit Operation and a 7 percent reduction in emissions of selenium, mercury, and arsenic compared to the Proposed Action 3-Unit Operation. Similar reductions are assumed for other COPECs relevant to special status wildlife species. As described in Section 3.11.4.3, NGS emissions are expected to pose negligible risk to special status wildlife species under the Proposed Action 3-Unit Operation and 2-Unit Operation. Under the 100-MW and 250-MW Renewable PFR alternatives, emissions and associated risks would be lower than those associated with the Proposed Action. Consequently, implementation of this alternative is expected to have no effect on special status wildlife species. Whereas plant emissions under the Renewable PFR Alternative would have no direct impact on special status species, when future plant emissions are combined with baseline conditions, there could be potential risk of mercury contamination to bald eagle populations within the Southwest Gap Region due to potentially elevated mercury levels associated with baseline conditions (Section 3.11.4.3).

3.11.4.5.1.2 Operations and Maintenance

Relative to the Proposed Action, there would be an incremental reduction in the amount of chemicals required by and trucked to the plant, a reduction in the amount of coal mined and transported to the plant via the BM&LP Railroad, and an associated reduction in coal combustion residuals trucked from the plant to the adjacent ash disposal site under the Renewable PFR Alternative. As operations and maintenance of NGS and associated facilities are expected to have negligible impacts on special status species under the Proposed Action, they also would have negligible impacts on special status wildlife species under the Renewable PFR Alternative.

3.11.4.5.2 Proposed Kayenta Mine Complex

3.11.4.5.2.1 Emissions and Deposition

Due to the reduction in mining and NGS power production under the 100-MW and 250-MW Renewable PFR alternatives there would be associated reductions in mine and plant emissions within the proposed KMC study area. As described in Section 3.11.4.3, results of the KMC ERA indicated that emissions from the mine, combined with those from NGS and baseline conditions, would pose negligible risk to special status wildlife species known or with potential to occur in the proposed KMC study area. Consequently, combined mine and plant emissions under the Renewable PFR Alternative are expected to have no effect on federally listed and other special status wildlife species within and adjacent to the mine permit boundary.

3.11.4.5.2.2 Operations and Reclamation

Under the Proposed Action, mining of new or expanded coal resource areas would have minor impacts to potentially suitable habitat for special status wildlife species that may occur in the proposed KMC study area. Like the Proposed Action, mine operations under the Natural Gas PFR alternatives would have a minor impact on potentially suitable habitat for special status wildlife species with potential to occur in the area. However, these impacts would be less than those expected under the Proposed Action 3-Unit Operation and 2-Unit Operation.

3.11.4.5.2.3 Groundwater Pumping

Water pumped from the N-Aquifer to support mine operations is assumed to be the same under the Renewable PFR Alternative as it would be under the Proposed Action. Because groundwater pumping under the Proposed Action would be expected to have negligible impacts on special status wildlife species, implementation of the 100-MW or 250-MW Renewable PFR alternatives also would have negligible impacts on special status wildlife.

3.11.4.5.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

Operation and maintenance of the WTS, STS, and communications sites would not change due to implementation of the Renewable PFR Alternative. Thus, impacts to special status wildlife species associated with operation and maintenance of the transmission systems and communication sites would be the same as the Proposed Action.

3.11.4.5.4 Project Impact Summary – All Project Components

Implementation of the either the 100-MW or the 250-MW Renewable PFR Alternative is expected to have negligible impacts on special status wildlife resources as a result of NGS plant and proposed KMC mine emissions. The combined new land disturbance at NGS at KMC under the Renewable PFR Alternative would be 3 to 4 percent less than the Proposed Action for the 100-MW alternative and 7 to 10 percent less for the 250-MW alternative. Impacts to special status wildlife species habitat would be considered minor under this alternative because most of the native habitats affected are already degraded as a result of their proximity to active mining areas and previous testing activities, and because special status species are not currently known to occur in the affected areas.

3.11.4.5.5 Cumulative Impacts

Although the degree of impact to special status wildlife species from implementation of the Renewable PFR Alternative are expected to be incrementally lower than those associated with the Proposed Action, cumulative impacts associated with this alternative are expected to be essentially identical to the cumulative effects described above for the Proposed Action.

3.11.4.6 Tribal Partial Federal Replacement Alternative

Under the Tribal PFR Alternative, between 100 MW and 250 MW of power generation from the NGS would be replaced by power supplied by a new photovoltaic generation facility on tribal land, displacing an equivalent amount of power from the federal share of NGS generation. The construction of a new photovoltaic generation site on tribal land would result in between 1,200 and 3,000 acres of new surface disturbance. The Tribal PFR facility would be analyzed in a separate National Environmental Policy Act process once a facility location is identified.

3.11.4.6.1 Navajo Generating Station

3.11.4.6.1.1 Emissions and Deposition

Under the Tribal PFR Alternative, NGS stack emissions of heavy metals and other COPECs would be reduced relative to the Proposed Action. For example, under the 100-MW Tribal PFR Alternative, there would be a 3 percent reduction in selenium, mercury, and arsenic emissions relative to the Proposed Action 2-Unit Operation and a 2 percent reduction in emissions of these metals relative to the Proposed Action 3-Unit Operation. Similarly, under the 250-MW Tribal PFR Alternative, there would be an 8 percent reduction in emissions of these trace metals relative to the Proposed Action 2-Unit Operation and a 5 percent reduction in emissions of selenium, mercury, and arsenic compared to the Proposed Action 3-Unit Operation. Similar reductions are assumed for other COPECs relevant to special status wildlife species.

NGS emissions are expected to pose negligible risk to special status wildlife species under the Proposed Action 3-Unit Operation and 2-Unit Operation. Under the 100-MW and 250-MW Tribal PFR alternatives, emissions and associated risks would be lower than those associated with the Proposed Action. Consequently, implementation of this alternative is expected to have no effect on special status wildlife species. Whereas plant emissions under the Tribal PFR Alternative would have no direct impact on special status species, when future plant emissions are combined with baseline conditions, there could be potential risk of mercury contamination to bald eagle populations within the Southwest Gap Region due to potentially elevated mercury levels associated with baseline conditions (Section 3.11.4.3).

3.11.4.6.1.2 Operations and Maintenance

Relative to the Proposed Action, there would be an incremental reduction in the amount of chemicals required by and trucked to the plant, a reduction in the amount of coal mined and transported to the plant via the BM&LP Railroad, and an associated reduction in coal combustion residuals trucked from the plant to the adjacent ash disposal site under the Tribal PFR Alternative. As operations and maintenance of NGS and associated facilities are expected to have negligible impacts on special status species under the Proposed Action, they also would have negligible impacts on special status wildlife species under the Tribal PFR Alternative.

3.11.4.6.2 Proposed Kayenta Mine Complex

3.11.4.6.2.1 Emissions and Deposition

Due to the reduction in mining and NGS power production under the 100-MW and 250-MW Tribal PFR alternatives there would be associated reductions in mine and plant emissions within the proposed KMC study area. As described in Section 3.11.4.3, results of the KMC ERA indicated that emissions from the mine, combined with those from NGS and baseline conditions, would pose negligible risk to special status wildlife species known or with potential to occur in the proposed KMC study area. Consequently, combined mine and plant emissions under the Tribal PFR Alternative are expected to have no effect on federally listed and other special status wildlife species within and adjacent to the mine permit boundary.

3.11.4.6.2.2 Operations and Reclamation

Under the Proposed Action, mining of new or expanded coal resource areas and relocation of Indian Route 41 through the proposed KMC would have minor impacts to potentially suitable habitat for special status wildlife species that may occur in the proposed KMC study area. Like the Proposed Action, mine operations under the Tribal PFR alternatives would have a minor impact on potentially suitable habitat for special status wildlife species with potential to occur in the area. However, these impacts would be less than those expected under the Proposed Action 3-Unit Operation and 2-Unit Operation.

3.11.4.6.2.3 Groundwater Pumping

Water pumped from the N-Aquifer to support mine operations is assumed to be the same under the Tribal PFR Alternative as it would be under the Proposed Action. Because groundwater pumping under the Proposed Action would be expected to have negligible impacts on special status wildlife species, implementation of the 100-MW or 250-MW Tribal PFR alternatives also would have negligible impacts on special status wildlife.

3.11.4.6.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

Operation and maintenance of the WTS, STS, and communications sites would not change due to implementation of the Tribal PFR Alternative. Thus, impacts to special status wildlife species associated with operation and maintenance of the transmission systems and communication sites would be the same as the Proposed Action.

3.11.4.6.4 Project Impact Summary – All Project Components

Implementation of the either the 100-MW or the 250-MW Tribal PFR Alternative is expected to have negligible impacts on special status wildlife resources as a result of NGS plant and proposed KMC mine emissions. The combined new land disturbance at NGS at KMC under the Renewable PFR Alternative would be 2 to 3 percent less than the Proposed Action for the 100-MW alternative and 5 to 7 percent less for the 250-MW alternative. Impacts to special status wildlife species habitat would be considered minor under this alternative because most of the native habitats affected are already degraded as a result of their proximity to active mining areas and previous testing activities, and because special status species are not currently known to occur in the affected areas.

3.11.4.6.5 Cumulative Impacts

Although the degree of impact to special status wildlife species from implementation of the Tribal PFR Alternative are expected to be incrementally lower than those associated with the Proposed Action, cumulative impacts associated with this alternative are expected to be essentially identical to the cumulative effects described above for the Proposed Action.

3.11.4.7 No Action

3.11.4.7.1 Navajo Generating Station

If continued operation of NGS and the BM&LP Railroad is not approved, the power plant would be decommissioned, and the operating and support facilities at the plant site would be dismantled and demolished to ground level over the course of one year. As described in Chapter 2.0, the water supply facilities and certain buildings and equipment would remain in accordance with the terms of the 1969 Lease and Lease Amendment No. 1 (or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1). Except for hazardous materials and parts and material salvaged, recycled, or sold for scrap, it is anticipated that demolished structure material would be placed within a landfill area on the plant site, and covered with soil. Hazardous materials would be transported and disposed in compliance with Resource Conservation and Recovery Act and other applicable requirements. Following decommissioning of the plant site, several buildings and other facilities would remain for use by the Navajo Nation and fences around the site and along the railroad would be left in place. Decommissioning of the BM&LP Railroad would involve removal of overhead power lines, rails, and ties. Railbed embankments would be abandoned in place and revegetated.

Currently, there are no special status wildlife species known or likely to occur in or immediately adjacent to the NGS plant site. Thus, decommissioning of the plant itself would have no effect on special status wildlife. As described in the Affected Environment section, above, there is potential for migrating southwestern willow flycatchers and western yellow-billed cuckoos to occur in the Begashibito Wash/Cow Springs area adjacent to the BM&LP Railroad. Should removal of the railroad take place when birds are in the area, the noise and human activity associated with this work could disturb these individuals, displacing them to portions of this habitat away from the railroad or to other migratory stopover habitats present along this wash, such as those around Tonalea, approximately 6 miles downstream. Such displacement would be unlikely to affect survival and reproduction of individuals. Over the long-term, decommissioning of NGS and associated facilities would open up approximately 3,500 acres of habitat for special status wildlife species such as the Houserock Valley chisel-toothed kangaroo rat, ferruginous hawk, and burrowing owl that have potential to occur in the desert scrub and grassland habitats in the area. Because fences would remain in place, larger special status species such as the desert bighorn sheep would not benefit from restoration of the plant site, and the railroad ROW would remain a barrier to the movement of this species.

3.11.4.7.2 Proposed Kayenta Mine Complex

If the continued operation at the proposed KMC is not approved, the mine would be closed and all active mining areas that exist in 2019 would be regraded and suitable overburden or spoil would be overlain with topsoil and seeded. Decommissioning of mine facilities would occur unless the facility has been approved by OSMRE as a permanent facility. Mine facilities with economic value would be demolished and the materials removed for salvage. Non-salvageable facilities would be buried. Concrete foundations and sub-bases would be removed or buried in place if approved by OSMRE. If the foundations are buried in place, the cover over these structures would be a minimum of 4 feet. Grading, topsoil replacement and seeding would occur for the facilities areas as described above. In some cases where facilities have been constructed with significant amounts of cut and fill, if approved by OSMRE, the cut and fill would be retained and blended with the surrounding areas. At the cessation of mining it is expected to take 3 to 5 years to fully abandon facilities and reclaim the surface.

Relative to the Proposed Action, the No Action Alternative would result in approximately 5,000 to 5,500 fewer acres of disturbance to wildlife habitat. Following reclamation of mine sites and facilities and cessation of human activity in the area, habitat for special status wildlife is expected to slowly increase in quality as native vegetation becomes established, spreads, and matures throughout the permit area. Potentially suitable Mexican spotted owl habitat is located less than two miles from active mining area N-9 and previously mined area N-11. It is unknown whether mining activities, environmental factors, and/or species-specific demographic and biogeographic factors have affected spotted owl nesting in the vicinity of the proposed KMC. However, to the extent that noise and light and/or human activity from past and current mining activities have prevented Mexican spotted owls from re-occupying historic Protected Activity Centers on Black Mesa, this species may move back into the area provided that population factors and other environmental factors (e.g., prey densities) are favorable. Other special status species such as the ferruginous hawk, golden eagle, and burrowing owl also are likely to move into the area as small mammal populations increase and ground squirrels and prairie dogs become established on reclaimed lands. While re-occupation of the site by special status wildlife also would be expected following decommissioning of the Proposed Action, under the No Action Alternative, this process would begin 25 years earlier, perhaps increasing the chances of recolonization by species whose ranges may shift out of the area over the next 25 years due to climate change.

3.11.4.7.3 Transmission Systems and Communication Sites

The NGS transmission system is an established part of the western U.S. transmission grid and supports reliability and delivery of power throughout the region, well beyond the power generated by the NGS. Therefore, under the No Action Alternative it is likely that that one, several, or all of the land owners/managers of the transmission line rights-of-way and communication site leases would renew some portion of the facilities to keep the power grid performing as expected.

In the event it is determined that some or all of the transmission systems and communication site ROWs are not renewed, a lengthy study and permitting process would need to occur before any decommissioning is initiated due to the essential and integral nature of these facilities with the western electric grid. As noted in Section 2.3.3, up to 4,826 acres within and alongside the transmission system corridors could be temporarily disturbed if the entirety of the transmission systems and communication sites were decommissioned and removed.

The impacts of these activities on special status wildlife species and their habitats generally would be the same as those discussed for the Proposed Action.

3.11.4.7.4 No Action Impact Summary – All Project Components

Under the No Action Alternative, there would be up to approximately 6,300 acres of potential special status wildlife habitat that would not be affected by continued operation of the NGS plant and Kayenta Mine. Whereas under the Proposed Action there are expected to be negligible to minor impacts to special status wildlife species associated with operations of the plant and mine, under the No Action Alternative there would be minor temporary impacts associated with facility decommissioning and reclamation activities followed by increasingly beneficial effects as native habitats rebound and existing levels of habitat fragmentation and degradation associated with proximity to disturbance decline.

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Section 3.12

Aquatic Biological Resources

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Acronyms and Abbreviations

1969 Lease	Navajo Project Indenture of Lease
BART	Best Available Retrofit Technology
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BMP	Best Management Practice
BM&LP Railroad	Black Mesa & Lake Powell Railroad
BO	Biological Opinion
CAP	Central Arizona Project
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CO_2	carbon dioxide
COPEC	chemical of potential ecological concern
Co-tenants	Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
Development Fund	Lower Colorado River Basin Development Fund
EIS	Environmental Impact Statement
ERA	Ecological Risk Assessment
ESA	Endangered Species Act of 1973
GCNRA	Glen Canyon National Recreation Area
HHRA	Human Health Risk Assessment
km	kilometer
KMC	Kayenta Mine Complex
kV	kilovolt
kW	kilowatt
MW	megawatt
N-Aquifer	Navajo Aquifer
NAC	Nevada Administrative Code
NEPA	National Environmental Policy Act of 1969, as amended
NGS	Navajo Generating Station
NGS Participants	U.S. (Reclamation), Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
NHPA	National Historic Preservation Act
NNEPA	Navajo Nation Environmental Protection Agency
NO_2	nitrogen dioxide
NO_X	nitrogen oxide
NPS	National Park Service
OSMRE	Office of Surface Mining Reclamation and Enforcement
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 microns or less

PFR	Partial Federal Replacement
PWCC	Peabody Western Coal Company
Reclamation	U.S. Bureau of Reclamation
ROW	Right-of-way
SO_2	sulfur dioxide
SRP	Salt River Project Agricultural Improvement and Power District
STS	Southern Transmission System
U.S.	United States
USEPA	U.S. Environmental Protection Agency
WTS	Western Transmission System

Contents

3.12 Aquatic Biological Resources 3.12-1
3.12.1 Regulatory Framework 3.12-1
3.12.2 Study Areas 3.12-2
3.12.2.1 Proposed Action and Action Alternatives 3.12-2
3.12.2.2 Cumulative 3.12-4
3.12.2.3 Ecological Risk Assessment – Role in Assessing Baseline Risk and Environmental Consequences 3.12-4
3.12.3 Affected Environment 3.12-7
3.12.3.1 Navajo Generating Station 3.12-7
3.12.3.2 Proposed Kayenta Mine Complex 3.12-17
3.12.3.3 Transmission Lines and Communication Sites 3.12-18
3.12.4 Environmental Consequences 3.12-19
3.12.4.1 Issues 3.12-19
3.12.4.2 Assumptions and Impact Methodology 3.12-19
3.12.4.3 Proposed Action 3.12-23
3.12.4.4 Natural Gas Partial Federal Replacement Alternative 3.12-40
3.12.4.5 Renewable Partial Federal Replacement Alternative 3.12-45
3.12.4.6 Tribal Partial Federal Replacement Alternative 3.12-46
3.12.4.7 No Action 3.12-48
3.12.5 References 3.12-50

List of Tables

Table 3.12-1 Relevant Statutes, Regulations, and Policies for Aquatic Species 3.12-1
Table 3.12-2 Non-native Fish Species in Lake Powell, Colorado River Gap Regions, and San Juan River 3.12-9
Table 3.12-3 Sport Fish Spawning Periods and Habitat 3.12-11
Table 3.12-4 Range in Average Fish Tissue Concentrations 3.12-13
Table 3.12-5 Risk of Mercury Baseline Conditions to Aquatic Species in the NGS Near-field and Gap Regions 3.12-14
Table 3.12-6 Risk of Selenium Baseline Conditions to Aquatic Species in the NGS Near-field and Gap Regions 3.12-14
Table 3.12-7 Risk from Arsenic, Mercury, and Selenium Baseline Conditions to Aquatic Species in the San Juan River Analysis Area 3.12-16
Table 3.12-8 NGS Near-field ERA Potential Impacts of Mercury and Selenium Emissions and Deposition from Baseline Conditions and NGS on Aquatic Species, 2020 – 2074 ... 3.12-24
Table 3.12-9 Gap Regions ERA Potential Impacts of Metal Emissions and Deposition from Baseline Conditions and NGS on Aquatic Species, Years 2020 – 2074 .... 3.12-26
Table 3.12-10 San Juan River ERA Potential Impacts of Metal Emissions and Deposition from Baseline Conditions and NGS on Aquatic Species, 2020 – 2074 .... 3.12-28
Table 3.12-11 NGS Water Use Impacts on Aquatic Biological Resources 3.12-29
Table 3.12-12 Impacts to Aquatic Species from Mining Disturbance 3.12-30
Table 3.12-13 Proposed KMC ERA Potential Impacts on Aquatic Species for All COPECs 3.12-32
Table 3.12-14 Measured Fish Tissue Concentrations (Refined) for Adult Non-Special Status Species and Relative Contribution of NGS Operations to Total Cumulative Sources, 2020 – 2074 .... 3.12-35
Table 3.12-15 Comparison of Mercury Hazard Quotients in Adult Fish Tissue 3.12-42

List of Figures

Figure 3.12-1 Aquatic Biological Resources for the NGS and Proposed KMC 3.12-3
Figure 3.12-2 Aquatic Biological Resources for Transmission Systems 3.12-5

3.12 Aquatic Biological Resources

3.12.1 Regulatory Framework

Laws, regulations, and policies that directly influence management decisions for the project primarily are implemented by the U.S. Fish and Wildlife Service (USFWS), Navajo Nation, Hopi Tribe, Bureau of Land Management (BLM), National Park Service (NPS), U.S. Forest Service, and state agencies (Arizona Game and Fish Department, New Mexico Department of Game and Fish, Nevada Division of Wildlife, and Utah Division of Wildlife Resources). Prominent laws, regulations, directives, and agreements relevant to aquatic biological resources are included in **Table 3.12-1**.

Table 3.12-1 Relevant Statutes, Regulations, and Policies for Aquatic Species

Statutes, Regulations, and Policies	Summary
BLM Manual 6500	• The BLM Manual 6500 declares that it is the BLM policy to manage habitat with emphasis on ecosystems to ensure self-sustaining populations and a natural abundance and diversity of wildlife, fish, and plant resources on public lands. The Manual further states that to carry out the above policy, the BLM will do inventory, planning, research, monitoring, and maintenance; will communicate, cooperate, and automate; and will hire professional staff.
BLM Resource Management Plans	• The Arizona Strip Field Office, Safford District, Bradshaw-Harquahala, Kanab Field Office, Las Vegas and Pahrump Field Office, Ely District, Phoenix, and the St. George Resource Management Plans specify regulations and goals for management of BLM-administered lands and set restrictions to protect fish and wildlife and the habitats on which they depend.
NPS Comprehensive Fisheries Management Plan	• The Comprehensive Fisheries Management Plan was developed in coordination with the Arizona Game and Fish Department and USFWS and includes: fisheries management goals and objectives for specific waters within both NPS units and a comprehensive "toolbox" of fisheries management techniques, such as: – Stocking of sterile (non-spawning) rainbow trout in Lees Ferry in the event the fishery declines; – Translocations (i.e., moving fish from one location to another) of native fish species, including endangered humpback chub; – Removing high risk non-native fish from selected areas that are important for native fish, including through targeted volunteer angler-facilitated river trips in Marble Canyon, and comprehensive mechanical trout control in and near Bright Angel Creek; beneficial use of all non-native fish removed; and – An experimental adaptive strategy for evaluating razorback sucker habitat suitability in the western portions of Grand Canyon.
U.S. Forest Service Land and Resource Management Plans	• The Coconino and Tonto National Forest Land and Resource Management Plans identify goals for forest health and constraints on resource use to meet these goals. LRMPs also identify project restrictions to protect fish and wildlife and Management Indicator Species for each forest.
Navajo Nation Biological Resource Land Use Clearance Policies and Procedures, Code RCS-44-08[1]	• The purpose of the Navajo Nation Biological Resource Land Use Clearance Policies and Procedures is to assist the Navajo Nation government and chapters ensure compliance with federal and Navajo laws which protect, wildlife resources, including plants, and their habitat resulting in an expedited land use clearance process. The Resource Land Use Clearance Policies and Procedures assists in directing development to areas where impacts to wildlife and/or their habitat will be less significant. Development includes but is not limited to human activities that result in permanent structures, temporary, long-term, or repetitive disturbance to wildlife or habitat as defined by Navajo Nation Code 17 Navajo Nation Code § 500 et. Seq.

Table 3.12-1 Relevant Statutes, Regulations, and Policies for Aquatic Species

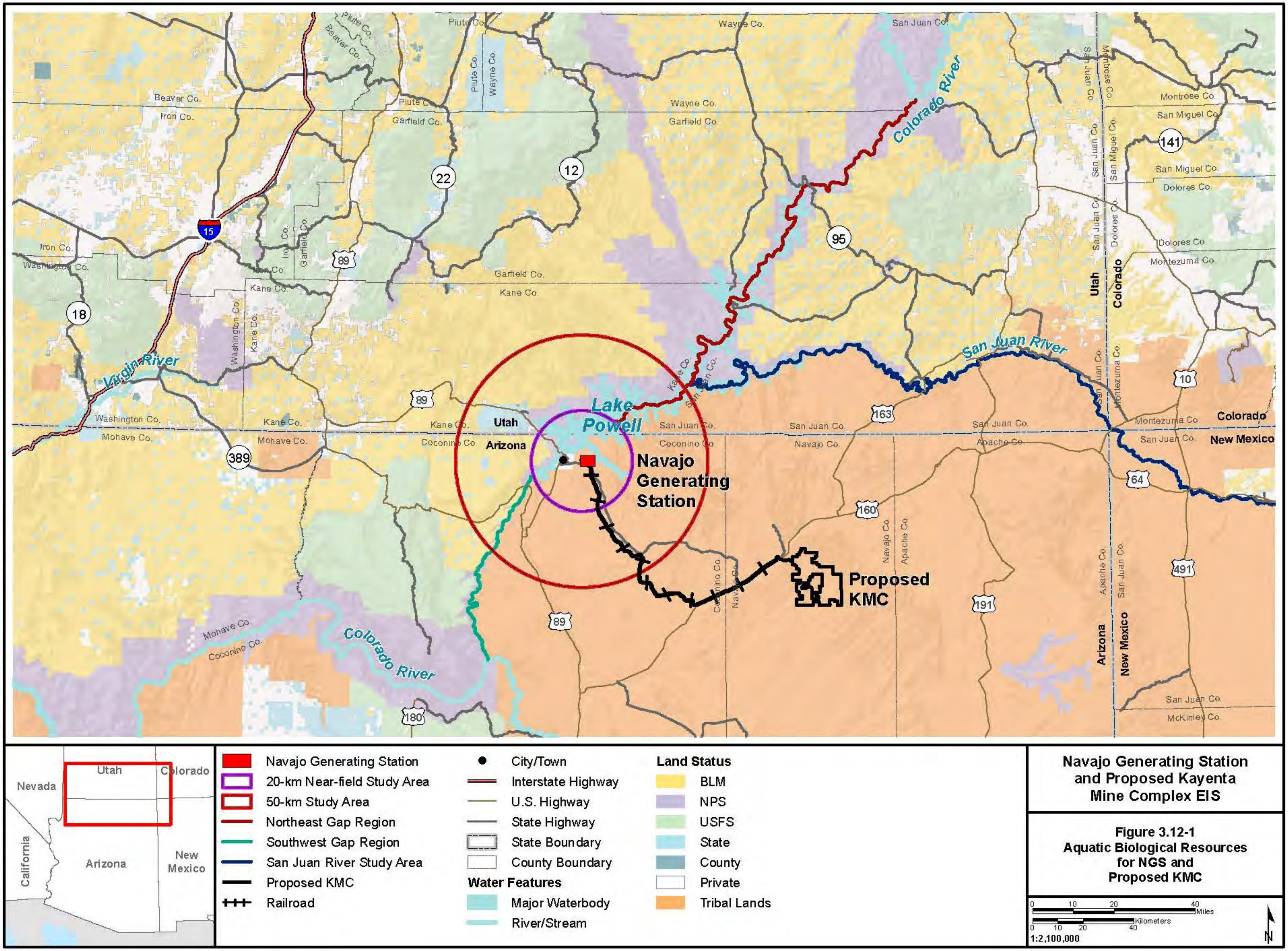
Statutes, Regulations, and Policies	Summary
Arizona Game and Fish Title 17, Game and Fish, Wildlife Habitat Protection, Aquatic Invasive Species	• The State of Arizona's Title 17 – Game and Fish Revised Statutes establish policies and programs for the management, preservation, and harvest of wildlife including aquatic species. Policies directed at managing and conserving aquatic species including invasive species programs and lists, funding/fiscal provisions, rules regarding taking and handling wildlife, and other prohibitions.
New Mexico Title 19 – Natural Resources and Wildlife, Chapter 31, Hunting and Fishing	• Rule 19 New Mexico Administrative Code 31.4, Hunting and Fishing, Part 4 Fisheries describes rules, regulations, and protection for sport fish. The issuing agency is New Mexico Department of Game and Fish.
Nevada Administrative Code (NAC) 503.060, NAC 503.072, and NAC 503.075.	• NAC 503.060 establishes classifications for sport fish species. NAC 503.072 classifies injurious aquatic species. NAC 503.075 classifies amphibians as game, protected, threatened, sensitive, endangered, and unprotected.
Utah Code 23-14-1, 23-48, and Rules R57-13, and R657-53	• Section 23-14-1 of the Utah State Code directs the Utah Division of Wildlife Resources to protect, propagate, manage, conserve, and distribute protected wildlife throughout the state. This statute also authorizes Utah Division of Wildlife Resources to identify and delineate crucial seasonal wildlife habitats. • R657-13 establishes rules for taking of fish and crayfish. • R657-53 establishes rules for amphibian and reptile collection, importation, transportation, and possession.

[1] Applies to the proposed KMC only. Under the 1969 Lease, the Navajo Nation agreed not to regulate the construction, maintenance or operation of NGS facilities, including the BM&LP Railroad, as well as the WTS and STS on Navajo Nation land.

3.12.2 Study Areas

3.12.2.1 Proposed Action and Action Alternatives

The study area for aquatic biological resources was determined by relating fish species and general aquatic community occurrences to the three project components: Navajo Generating Station (NGS), proposed Kayenta Mine Complex (KMC), and the Western and Southern transmission line systems (WTS and STS). The NGS portion of the study area was further divided geographically into three deposition impact areas with each focused on fish species and aquatic community occurrence and aquatic habitat parameters that were defined within the context of the ecological risk assessment (ERA) (**Figure 3.12-1**). The areas were delineated based on an iterative process during the development of the risk assessments in coordination with cooperating agencies. Coordination for the emission/deposition study areas was completed as part of the process for defining sampling locations, data review, and methodologies for the ERAs (Ramboll Environ 2016a,b,c,d).



Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 3.12-1
Aquatic Biological Resources for NGS and Proposed KMC

7/20/2016

As discussed in Section 3.0.2, Ecological and Human Health Risk Assessments, three ERAs were conducted to analyze the effects of NGS emissions and the resulting deposition of chemicals on ecological receptors in Lake Powell and a portion of the Colorado River below Glen Canyon Dam (NGS Near-field ERA), the Colorado River (Northeast and Southwest Gap Regions) beyond the near-field area, and the San Juan River (San Juan River ERA). The NGS Near-field study area consists of a 20-kilometer (km) radius from the NGS Facility that overlaps with a portion of Lake Powell. The Northeast Gap Region extends from 20-km extent of the near-field area in Lake Powell upstream to the confluence with the Green River. The Southwest Gap Region extends from Lees Ferry downstream to the confluence with the Little Colorado River. The San Juan River study area extends from the San Juan River arm in Lake Powell upstream in the San Juan River to the Farmington area.

The portion of the overall study area involving the proposed KMC included the mine boundary for emission effects and surface disturbance (**Figure 3.12-1**). The study area for groundwater effects on aquatic species was the N-Aquifer. A detailed discussion of the groundwater study area is provided in Water Resources, Section 3.7.3. A separate proposed KMC ERA was conducted to evaluate existing baseline conditions and potential future environmental conditions in the vicinity of the proposed KMC (Ramboll Environ 2016d).

The portion of the study area involving the transmission systems consists of the perennial streams crossed by the WTS and STS rights-of-way (ROWs) (**Figure 3.12-2**). The basis for focusing on perennial streams for aquatic biological resources is that this type of waterbody provides habitat throughout the year. The study area for the transmission systems included the ROW and an additional 500-foot width on either side of the ROW to cover access roads.

3.12.2.2 Cumulative

The cumulative effects study area is expanded to include cumulative sources in the Upper Colorado River Basin and the upstream portion of the San Juan River to the Navajo Dam. The portion of the Colorado River below Glen Canyon Dam is extended downstream to the inflow to Lake Mead.

3.12.2.3 Ecological Risk Assessment – Role in Assessing Baseline Risk and Environmental Consequences

The potential for risk to aquatic biological resources was evaluated under current conditions (referred to as baseline or baseline conditions), and potential future conditions that considers the deposition of chemicals from NGS emissions and emissions due to mining activity necessary to support NGS operations, plus cumulative effects. The ERAs were intended to (1) investigate whether the combination of site-specific exposure scenarios and chemicals of potential ecological concern (COPECs) may pose current or potential future risks to ecological receptors, and (2) provide information necessary to support the Environmental Impact Statement (EIS) process. Ecological risk assessment involves four key components: problem formulation, analysis (exposure/toxicity assessment), risk characterization and uncertainty analysis. Section 3.0.2 provides an overview of the ERA process and key risk assessment concepts, and **Appendix 3RA** provides further detail of the process and a summary of the ERAs conducted for the project. The reader is directed to each of the ERAs (Ramboll Environ 2016a,b,c,d) for specific detail and rationale for the data evaluated and analyses conducted.

For evaluation of aquatic resources, the outcome of the problem formulation (conceptual site model) identified three key receptors for evaluation. These receptors are described in the context of assessment endpoints (explicit expression of the environmental value to be protected), and measures of effect (ecological characteristic[s] that quantify the assessment endpoint) as defined by U.S. Environmental Protection Agency (USEPA) guidance (USEPA 1997). The following assessment endpoints and measures of effect were defined for aquatic receptors in each of defined study areas for the project (NGS Near-field, Gap Regions, San Juan River and proposed KMC analysis areas):

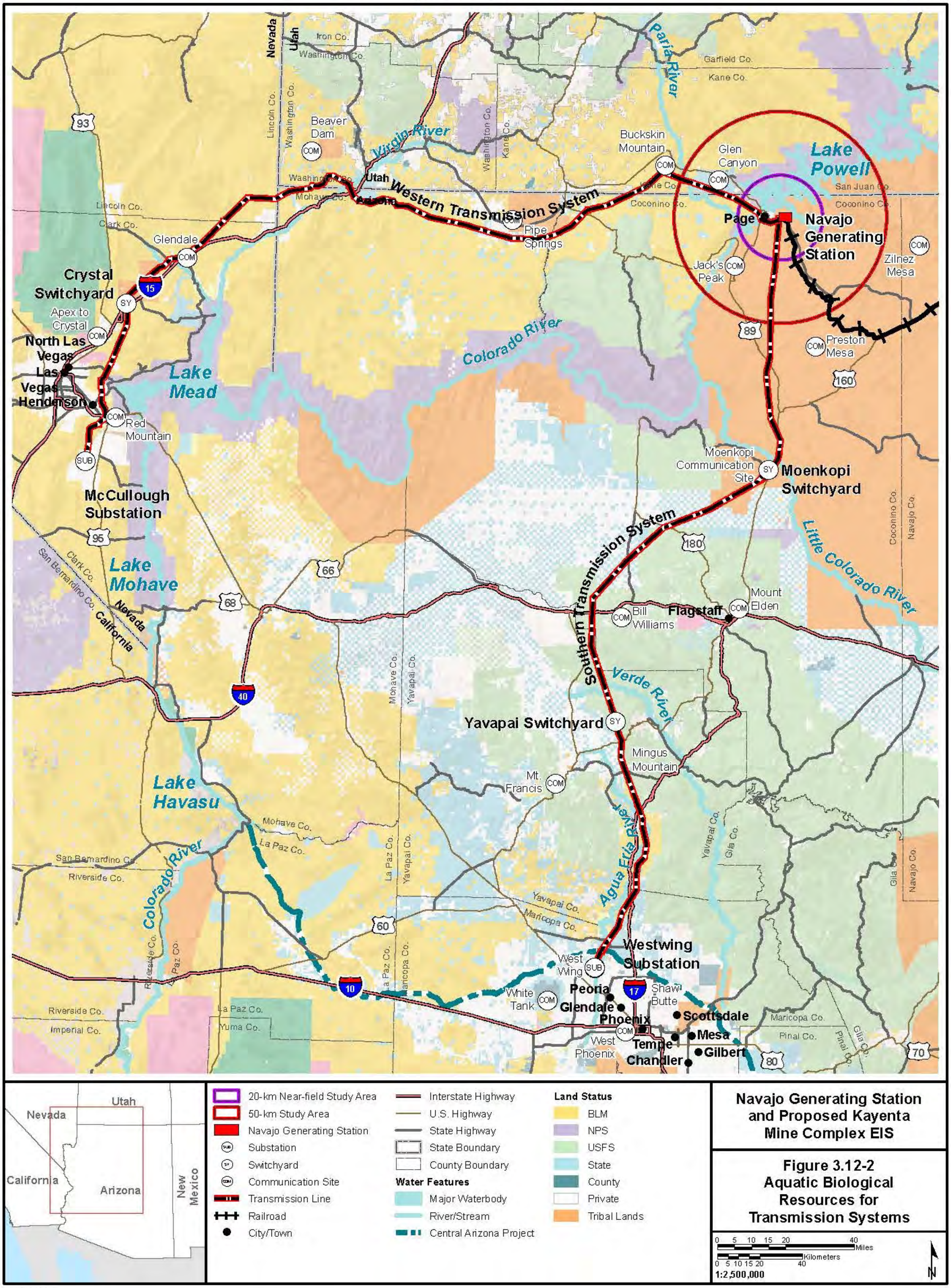


Figure 3.12-2
Aquatic Biological Resources for Transmission Systems

- Benthic (Sediment) Invertebrate Community
  - Assessment Endpoint: protection and maintenance of benthic invertebrate community.
  - Measure of Effect – comparison of sediment concentrations to ecological sediment quality screening values available in the literature.
- Aquatic Community (Water Column Invertebrate Community, Aquatic Plant Community, and Fish/Amphibians)
  - Assessment Endpoint: protection and maintenance of the aquatic community within the defined analysis area.
  - Measure of Effect – comparison of surface water concentrations to water quality screening values (federal, state, or tribal ambient water quality criteria).
- Fish (Fish Populations, including sport and non-sport fish)
  - Assessment Endpoint: protection and maintenance of fish within the defined analysis area.
  - Measure of Effect - comparison of surface water concentrations to water quality screening values (federal, state, or tribal ambient water quality criteria).
  - Measure of Effect – comparison of measured (based on available literature) and/or modeled fish tissue concentrations to tissue-based thresholds identified in available literature.

The Exposure Assessment of the ERAs (Ramboll Environ 2016a,b,c,d) present the assumptions and parameters used to develop estimates of exposure, which specifically includes determination of environmental concentrations to which a given receptor may be exposed (exposure point concentrations). For ecological communities (groups of actually or potentially interacting species living in the same area), such as each of the receptors identified for evaluation of aquatic biological resources, contaminant exposure is based on the integration of all exposure routes (e.g., exposure via gills, food intake, and direct contact); i.e., food web modeling was not done for these aquatic communities as detailed exposure/food web models are generally not available for community level receptors.

The Analysis or Effects Assessment (USEPA 1998, 1997) phase of the ERAs compiles available toxicity information and correlates receptor exposure to the potential for an undesirable effect to organism health, where a medium-specific (sediment, water or tissue) screening benchmark or critical body residue is identified and subsequently used to characterize the potential for risk. The quantitative metric used to characterize risk, conducted within the context of the Risk Characterization phase, is the Hazard Quotient (HQ). Information regarding how HQs are calculated, and interpretation of the HQ was summarized in Chapter 3.0.2 and is detailed in **Appendix 3RA** and the individual ERA reports (Ramboll Environ 2016a,b,c,d). The risk characterization for the aquatic community and sediment community resulted in a HQ based on comparison of surface water and sediment exposure concentrations to recognized regulatory and literature-based screening concentrations protective of aquatic life and benthic organisms, respectively. The HQ used for the evaluation of fish was based on comparison of literature-based fish tissue toxicity threshold concentrations, known as critical body residues, against data compiled from the literature for each of the study areas. A HQ was reported in the ERAs for individual fish species for which literature-based fish tissue concentrations were available. In addition, the HQ based on the average fish tissue concentration for all species in the compiled dataset also was reported for each study area. Consideration of HQs based on average tissue concentration for multiple fish species is generally representative of the fish community as a whole.

As described in Section 3.0.2, HQs were calculated for each NGS operation scenario to account for current and potential future conditions: baseline, 3-Unit Operation, 2-Unit Operation, 2-Unit Operation with Partial Federal Replacement (PFR) and other cumulative sources. Given the number of scenarios evaluated, all COPECs and receptors were carried forward throughout the ERA process such that a total cumulative sources risk estimate that incorporates baseline, a given NGS production operation (deposition-related contributions) and other cumulative sources (e.g., baseline + 3-Unit Operation + OCS) could be determined (Ramboll Environ 2016a,b,c,d). For each of these scenarios, HQs were developed for the maximum, refined, and average exposure scenarios for all receptors. The refined HQs are most relevant because these values are based on an estimated upper end average exposure using toxicity data that are considered protective of populations and communities. The refined HQ results are based on comparison of the exposure point concentration represented by the 95 percent upper confidence limit on the arithmetic average wherever it could be calculated, as described in Section 3.0.2. Use of this value generally represents a more realistic estimate of exposure versus use of a maximum concentration and resulting maximum HQ, as ecological receptors are unlikely to be exposed to the highest level of all COPECs at all times (an unrealistic and highly conservative assumption). For these reasons, the environmental consequences sections use the refined HQs as an indicator of risk to aquatic species. Section 3.0.2 provides an overview of interpretation of HQs.

3.12.3 Affected Environment

Aquatic habitats associated with NGS and associated facilities including the Black Mesa & Lake Powell (BM&LP) Railroad, are located in the Great Basin Desert scrub and Plains and Great Basin Grasslands biotic communities (Brown et al. 2007). The waterbodies in this ecoregion consist mainly of ephemeral and intermittent streams, with variations in the number of springs from few to abundant depending on the sub-ecoregion. Although the region is dominated by streams with temporary or seasonal flow, Lake Powell, the Colorado River, and the San Juan River provide perennial habitat within the NGS deposition analysis areas.

Aquatic habitat within the BM&LP Railroad and proposed KMC study areas mainly consists of ephemeral and intermittent streams. Species diversity is reduced in these waterbodies compared to perennial habitat. Water is present on a relatively consistent basis in portions of some streams where groundwater input is available. Perennial habitat within the transmission ROWs varies between small streams and large rivers such as the Colorado River. No perennial habitat is located near the communication sites.

3.12.3.1 Navajo Generating Station

3.12.3.1.1 Habitat

Perennial aquatic habitat in the NGS deposition area is provided by Lake Powell. This large reservoir is formed by waters of the Colorado and San Juan rivers that are impounded by Glen Canyon Dam. The Glen Canyon National Recreation Area (GCNRA) encompasses most of the reservoir perimeter, with the Navajo Reservation on the south shore from the dam eastward along the San Juan River arm. Public access is unrestricted in the GCNRA, but there is no public access on reservation land. The reservoir is approximately 25 miles wide at its widest point, with a linear length of approximately 186 miles (U.S. Bureau of Reclamation [Reclamation] 2007; Utah Department of Environmental Quality- Division of Water Quality 2013). It is estimated to have more than 1,900 miles of shoreline, and the annual average elevation fluctuation is approximately 18 feet (Utah Department of Environmental Quality- Division of Water Quality 2013). Lake Powell fluctuates both annually and seasonally, based on inflow and dam releases. The lake pool elevation can rise more than 10 feet over a short period of time. The mean and maximum depths are 132 and 560 feet, respectively. Habitat types provided by Lake Powell include mainstem river inflow areas and littoral pelagial lentic habitats. Riparian vegetation around Lake Powell is extremely restricted because of the desert terrain around the perimeter and fluctuating water levels (Reclamation 2007).

Aquatic habitat related to the NGS water intake consists of a relatively deep portion of Lake Powell (depths exceeding 400 feet) at a site that is located approximately 1 mile east of Antelope Point (NPS 2007). The nearshore area also is deep as it drops vertical to the lake bottom. The lake bottom is dominated by sandstone with no underwater macrophyte vegetation.

Riverine aquatic habitat in the Northeast and Southwest Gap Regions is provided by the Colorado River. Habitat types in the Northeast Gap Region (Lake Powell upstream to the Colorado River confluence with the Green River) include parts of Lake Powell, slow-moving inflow areas in the Colorado arm, and relatively narrow riverine reaches with flow. A major canyon known as Cataract Canyon is located in the upper portion of the Northeast Gap Region. Cataract Canyon begins 4 miles downstream of the confluence with the Green River and extends approximately 37 miles (Badame 2008). The upper 10 miles of the canyon is within Canyonlands National Park and the lower 27 miles is within the GCNRA. Habitat in the upper section of the canyon mainly consists of large eddy/pool complexes interspersed between large rapids. Some of the larger pools are 75 feet deep. The lower 32 miles of Cataract Canyon are inundated by Lake Powell at full-pool elevation (Badame 2008). The types of aquatic habitat in the Southwest Gap Region (Glen Canyon Dam downstream to the confluence with the Little Colorado River) are influenced by geological conditions and a river with highly regulated flows and water temperatures that are perennially colder than Lake Powell inflows. Reclamation divides the Colorado River below Glen Canyon Dam into three segments. Beginning at Glen Canyon Dam, the first portion of the river is the 15-mile stretch that runs downstream through Glen Canyon to just upstream of the Paria River at Lees Ferry (RM 0). Glen Canyon has a substantially different geomorphic structure compared to the reaches farther downstream, and it has a limited sediment supply. The next section of river is the approximately 62-mile stretch that runs through Marble Canyon. This stretch starts at the mouth of the Paria River at Lees Ferry (RM 0) and extends to just upstream of the Little Colorado River confluence (RM 61.5). The sediment load of this reach is dominated by Paria River inputs. The third section runs through the Grand Canyon and comprises the remainder of the river downstream of the Little Colorado River. The sediment load of this third portion is the cumulative supply provided by contributions from the Paria River reach, the Little Colorado River, and various other small tributaries (Reclamation and NPS 2015).

Habitat types in the San Juan River below Navajo Dam vary in terms of channel characteristics. From Navajo Dam in New Mexico downstream to Farmington, the river is restricted to a single, moderately incised channel with a mixture of riffles, deep runs, and large pools (New Mexico Department of Game and Fish 2006). As the river progresses from Farmington to Shiprock, the gradient diminishes but flow primarily remains in a single channel. Downstream of Shiprock, the river frequently is divided among two to four channels with a more complex habitat diversity including backwaters, embayments, and shoals in combination with riffle, run, and pool habitats. The San Juan River flows approximately 120 miles in Utah before it enters Lake Powell. The portion of the river from the Arizona state line to Chinle Creek is characterized as a relatively broad and braided channel. From Chinle Creek to the San Juan arm of Lake Powell, the river channel meanders and cuts through steep canyons.

No perennial streams, springs, or ponds are located within the BM&LP Railroad 250-foot ROW, or other NGS facility ROW (i.e., water and pipeline ROW to pump station, and NGS and ash disposal access roads); therefore, no fish or other aquatic species are expected to be present and no further analysis was conducted. Ponds located within the NGS plant site are for industrial use and do not contain habitat for fish species.

3.12.3.1.2 Non-native Fish Species

3.12.3.1.2.1 Lake Powell

Common non-native fish species in Lake Powell include walleye, bluegill, green sunfish, carp, gizzard shad, and channel catfish (Arizona Game and Fish Department 2013; Reclamation 2007) (**Table 3.12-2**). Native fish species are discussed in Section 3.13, Special Status Aquatic Species. Non-native fish species associated with the Lake Powell tributaries and inflow areas include fathead minnow, mosquitofish, red shiner, and plains killifish. The pelagic (open water) area of Lake Powell is dominated by striped bass and threadfin shad (Vatland et al. 2008). The occurrence of these fish species in the pelagic zone is characterized as concentrated abundance separated by expanses of habitat with few fish (Mueller and Horn 2004).

Table 3.12-2 Non-native Fish Species in Lake Powell, Colorado River Gap Regions, and San Juan River

Common Name	Scientific Name	Sport Fish (S)	Lake Powell	Colorado River Northeast Gap Region	Colorado River Southwest Gap Region	San Juan River
Black bullhead	*Ameirus melas*	S	X	X	X	X
Black crappie	*Pomoxis nigromaculatus*	S	X	X	X	
Bluegill	*Lepomis macrochirus*	S	X	X	X	X
Brown trout	*Salmo trutta*	S			X	X
Carp	*Cyprinus carpio*		X	X	X	X
Channel catfish	*Ictalurus punctatus*	S	X	X	X	X
Fathead minnow	*Pimephales promelas*		X	X	X	X
Gizzard shad	*Dorosoma cepedianum*		X	X		
Green sunfish	*Lepomis cyanellus*	S	X	X	X	X
Largemouth bass	*Micropterus salmoides*	S	X	X	X	X
Mosquitofish	*Gambusia affinis*		X	X	X	X
Northern pike	*Esox lucius*	S		X		
Plains killifish	*Fundulus zebrinus*		X	X	X	X
Rainbow trout	*Oncorhynchus mykiss*	S	X	X	X	X
Red shiner	*Notropis lutrenis*		X	X	X	X
Sand shiner	*Notropis stramineus*			X		
Smallmouth bass	*Micropterus dolomieui*	S	X	X	X	X
Striped bass	*Morone saxatilis*	S	X	X	X	
Threadfin shad	*Dorosoma petenense*		X			
Walleye	*Sander vitreus*	S	X	X		
White sucker	*Catostomus commersoni*			X		X
Yellow bullhead	*Ameiurus natalis*	S	X	X	X	X

Source: Arizona Game and Fish Department 2013; Breen et al. 2011; Hart 2008; Reclamation 2007; Schleicher 2015; Skorupski et al. 2013; Utah Department of Environmental Quality- Division of Water Quality 2013.

The sport fishery in Lake Powell primarily is focused on striped bass (Reclamation 2007). Other sport fish species are represented by catfishes, sunfishes, largemouth bass, smallmouth bass, and walleye (Arizona Game and Fish Department 2013) (**Table 3.12-2**). Sport fish, forage fish, and other non-native fish occurrences in Lake Powell are from stocking, unintentional introductions, and movements of fishes into the lake from tributaries. Largemouth bass and crappie populations historically were the dominant sport fish species; however, they have declined in relative abundance in recent years due to a lack of habitat structure for young fish and competition with other fish species such as striped bass and gizzard shad (Reclamation 2007). Aging of the reservoir and water level fluctuations have eliminated most of the vegetative in nearshore areas. The change in vegetative cover led to the stocking of smallmouth bass and striped bass. Threadfin shad were introduced to provide a forage base for striped bass. The striped bass and threadfin shad populations in Lake Powell can show dramatic variations both seasonally and annually (Mueller and Horn 2004). Threadfin shad abundance usually peaks at 5- to 7-year intervals, while striped bass growth and abundance corresponds closely to peaks in threadfin shad foraging (Vatland et al. 2008). Fish species that occur within the intake area of Lake Powell consist of introduced sport species such as striped bass, largemouth bass, black crappie, walleye bluegill, channel catfish, and threadfin shad (NPS 2007). Numbers likely would be low for these species due to the deep water nature of the area. Threadfin shad and striped bass tend to utilize open water habitat. The bass and crappie species prefer areas with shallow nearshore areas.

The Arizona Game and Fish Department and Utah Division of Wildlife Resources issued a mercury fish consumption advisory for striped bass in October 2012 (Arizona Game and Fish Department 2012). The advisory recommends that pregnant women and children limit the consumption of striped bass caught in the southern portion of Lake Powell from the Dangling Rope Marina in Utah to the Glen Canyon Dam in Arizona. The advisory does not limit the consumption of other fish species taken from Lake Powell or the use of the lake for swimming, boating or other recreational activities.

3.12.3.1.2.2 Colorado River – Northeast Gap Region

Sport fish species in the Northeast Gap Region mainly consist of warmwater species such as northern pike, walleye, smallmouth bass, sunfishes, bullheads, and channel catfish. Rainbow trout is present in relatively low numbers. The most abundant non-native fish species in this section of the Colorado River include red shiner, sand shiner, and fathead minnow (Breen et al. 2011).

3.12.3.1.2.3 Colorado River – Southwest Gap Region

The NPS implemented a Comprehensive Fisheries Management Plan, in cooperation with Arizona Game and Fish Department, USFWS, Reclamation, and the U.S. Geological Survey-Grand Canyon Monitoring and Research Center, for GCNRA below Glen Canyon Dam and Grand Canyon National Park (NPS 2013). The purpose of the Comprehensive Fisheries Management Plan is to maintain: 1) a thriving native community within Grand Canyon National Park; and 2) a highly valued recreational trout fishery in the Glen Canyon reach. In 2015 the Arizona Game and Fish Department developed a Fisheries Management Plan for Lees Ferry designed to maintain and enhance a blue-ribbon rainbow trout fishery at Lees Ferry that does not adversely affect the native aquatic community in Grand Canyon National Park (Rogers 2015). Rainbow trout and brown trout are present below the dam, but rainbow trout have a robust reproducing population and dominant the fish species composition. A small reproducing brown trout population exists in Lees Ferry and has shown recent increases in abundance in the past two years (Winters et al. 2016). Flow regulation from Glen Canyon Dam is designed in part to minimize impacts to the rainbow trout fishery. Other management activities include a trout removal program at the mouth of the Little Colorado River confluence for the purpose of reducing trout predation on the federally endangered humpback chub. Other sport fish species that occur in the lower portion of the Glen Canyon Dam to the Little Colorado River segment include green sunfish, bluegill, largemouth bass, bullheads, and channel catfish (NPS 2013). The occurrence of these sport fish species is rare, since water temperatures are too cold in this stretch of the river and are likely fish that are passed through Glen Canyon Dam or reside in pockets of warm water (e.g., springs, sloughs).

3.12.3.1.2.4 Lower San Juan River

Based on recent monitoring studies in the San Juan River, sport fish species present in the San Juan River include black bullhead, yellow bullhead, channel catfish, smallmouth bass, largemouth bass, green sunfish, brown trout, and rainbow trout (Gilbert 2014; Schleicher 2015; Schleicher and Ryden 2013). All of these introduced species are uncommon (1 to 5 percent of the total catch) or rare (less than 1 percent of the catch) except for channel catfish, which is considered to be common (5 percent or greater of the total catch). Channel catfish numbers in the middle and lower portions of the San Juan River have been fairly stable in recent years; however, adult numbers were considerably reduced downstream of the hogback diversion dam in 2013. Channel catfish is one of the non-native fish species that is targeted in the non-native fish removal program. In the San Juan River, non-native fish species tend to increase in abundance in the lower reaches of the river.

3.12.3.1.2.5 Fish Spawning

General spawning periods and habitat for the more common sport fish species within the study area are provided in **Table 3.12-3**. The spawning periods are approximate, could occur in only a portion of a particular month, and could vary based on different temperature regimes within the northern and southern portions of the analysis area.

Table 3.12-3 Sport Fish Spawning Periods and Habitat

	Months												
Species or Group	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**Spawning Habitat**
Brown trout									■	■			Stream spawners that use tributary streams with gravel substrates in riffle-run areas.
Rainbow trout			■	■	■								Stream spawners that use gravel substrates at head of riffle or downstream portion of pool.
Walleye				■	■								Spawn in lakes and streams in shallow water over rock substrates.
Black bullhead						■	■						Usually spawn in weedy or muddy shallow areas by building nests.
Channel catfish					■	■	■						Prefers areas with structure such as rock ledges, undercut banks, logs, or other structure where it builds nests.
Largemouth bass					■	■	■						Shallow areas over clean gravel and sand bottoms.
Smallmouth bass				■	■	■	■						Builds nests in shallow areas over boulder, cobble, or gravel substrates.
Crappies					■	■	■	■					Spawning is often in open water, typically over mud, sand or gravel bottoms. Prefer sites near vertical cover such as trees or rocks.
Sunfishes					■	■	■	■					Nest builders in diverse substrates and shallow depths.
Striped bass				■	■	■							Egg masses deposited over sand bars, submerged vegetation, or other instream debris.

Source: Arizona Game and Fish Department 2015a.

3.12.3.1.3 Invertebrates

Quagga (*Dreissena bugensis*) and zebra mussels *(Dreissena polymorpha)* are small freshwater mussels that have invaded North America, specifically the Great Lakes. In January 2007 they were found in the Colorado River system (i.e., Lake Mead and Lake Havasu) (NPS 2007) and the mussels are currently present in portions of Lake Powell (NPS 2016). The mussels and their larvae are transported in the ballast water or on the engines and hulls of boats. In addition to being prolific invaders and upsetting the ecological balance of lakes and other aquatic systems, quagga mussels are notorious for clogging water intake systems, thus creating maintenance issues. Quagga and zebra mussels bioaccumulate metals, which represents a source of metals in aquatic the aquatic food chain that can be transferred to birds and fish as part of their diet (Kwan et al. 2003; Muetting and Gerstenberger 2010). Quagga mussels have been identified as a biomonitoring indicator of metal contamination in lakes (Muetting and Gerstenberger 2010).

3.12.3.1.4 Amphibians

The canyon tree frog (*Hyla arenicolor*) is common along the shores of Lake Powell and relatively steep side canyons (Brennan 2008; Reclamation 2007). Other amphibian species that are known to occur around Lake Powell or the Colorado River include the Woodhouse's toad (*Anaxyrus woodhousii*), red-spotted toad (*Anaxyrus punctatus*), Great Basin spadefoot (*Spea intermontana*), tiger salamander (*Ambystoma tigrinum*), and northern leopard frog (*Lithobates pipiens*). Woodhouse's toad and red-spotted toad generally are associated with riparian areas along the Colorado River in the spring and fall and use the shoreline area in the summer. The Great Basin spadefoot typically is associated with water tanks or wet ditches. Northern leopard frog has disappeared from 70 percent of the known sites above and below Glen Canyon Dam (Reclamation 2007). Although potential habitat exists for this species, but no current populations are known to be present around Lake Powell or near the Colorado River.

3.12.3.1.5 Baseline Characterization for Chemicals of Potential Ecological Concern in Surface Water, Sediment, and Fish Tissue

The COPECs for evaluation for the project were defined in each of the ERAs (Ramboll Environ 2016a,b,c,d) and were identified based on two previous studies conducted by Electric Power Research Institute (EPRI) (EPRI 2009, 2011) and agreement by cooperating agencies regarding project scope in development of the ERAs. These chemicals are associated with coal and coal-fired power plants and included 24 metals (inorganic chemicals), two broad chemical classes of organic compounds (polycyclic aromatic hydrocarbons, or PAHs, and dioxins/furans), and two other organic compounds, benzene and acrolein. Of the COPECs evaluated, only mercury and selenium were identified with refined risk estimates greater than or equal to 1 (refined HQ≥1) for evaluation of fish, surface water, and sediment; refined concentrations were acceptable and below applicable ecological screening level values for all other COPECs. Baseline (current) conditions are described below.

This section summarizes the potential risk to aquatic species from mercury and selenium baseline (current or existing) conditions within the NGS study areas based on the ERAs conducted for the NGS Near-field (Lake Powell), Colorado River (Gap Regions), and the San Juan River (Ramboll Environ 2016a,b,c). The term "baseline condition" is used in this section and the impact discussions for the action alternatives to be consistent with the terminology used in the ERAs, as defined in Section 3.0.2., or briefly, environmental conditions before any future Project activities have taken place. Details regarding the potential effects of mercury and selenium on aquatic species are summarized in the Ecological Risk Assessment Summary, **Appendix 3RA**, and detailed in the ERA documents (Ramboll Environ 2016a,b,c).

Fish tissue concentrations were modeled from surface water data (using chemical-specific uptake factors) or, where available, from measured tissue concentrations available in the literature. Measured fish tissue data for mercury and selenium for sport and non-sport fish species occurring within the ERA study areas are summarized in **Table 3.12-4**. The values presented represent the average whole body fish tissue concentrations that were reported in the summary statistics for the ERA reports (Ramboll Environ 2016a,b,c).

Table 3.12-4 Range in Average Fish Tissue Concentrations

Chemical	Fish Tissue Concentration (mg/kg wet weight)			
	NGS Near-field (Colorado River/ Lake Powell)	Northeast Gap (Colorado River/ Lake Powell)	Southwest Gap (Colorado River)	San Juan River
Mercury (River)	0.02	0.029 – 0.15	0.041 – 1.32	0.0078 – 0.17
Mercury (Lake)[1]	0.12 – 0.2	0.072 – 0.15	--	--
Selenium[1]	--	--	0.42 – 3.85	0.44 – 2.14

[1] -- Indicates that measured tissue data were not available or not applicable.

These measured tissue data were derived from a number of sources including Utah Division of Water Quality (for years 2005 - 2010), National Park Service, USEPA, and United States Geological Survey and Walters et al. (2015), USFWS (2014), Kepner (1988) and Simpson and Lusk (1999). Source of data for all media is summarized in **Appendix 3RA** and detailed in the ERA reports (Ramboll Environ 2016a,b,c).

The effects assessment for water column aquatic species (aquatic community and fish) was based on the comparison of dissolved surface water concentrations to surface water ecological benchmarks. A second effects assessment for fish was conducted by comparing modeled or measured (from the literature) fish tissue concentrations to literature-based critical body residues. Fish tissue-based critical body residues were used to determine the potential for adverse effect based on the assessment endpoint and measure of effect defined in Section 3.12.3. Fish tissue-based critical body residues and the literature-derived tissue concentrations consider total exposure to fish, which is an integrated exposure that reflects uptake and assimilation of the bioavailable fraction of COPECs across multiple pathways, including respiration (via gills), sediment contact/ingestion, and diet. The critical body residues used to evaluate risk are listed below.

- Mercury – For evaluation of early life stage fish, the threshold or no observed effect level of 0.2 mg/kg wet weight per Beckvar et al. (2005) was used. For adult fish, the lowest observed effect level of 0.77 mg/kg wet weight per Dillon et al. (2010) was used.
- Selenium – For evaluation of early life stage fish and adult fish, the threshold no observed effect level of 2 mg/kg wet weight was used (USEPA 2015).

For larval amphibians (tadpoles), potential risk was evaluated using surface water benchmarks protective of aquatic communities, as above, and literature-derived screening concentrations protective of larval amphibians (Sparling et al. 2010). To address adult amphibians, rainbow trout was used as a surrogate species to allow evaluation of potential amphibian exposure (via the diet) to aquatic invertebrates, which also are consumed by predatory fish. A portion of amphibian diet also may come from terrestrial sources.

Refined risk estimates for mercury and selenium exposure for aquatic species are discussed below and summarized in **Tables 3.12-5** and **3.12-6** for the NGS Near-field ERA and Gap Region ERA analysis areas. The HQ values presented in these tables are based on are refined exposure point concentrations (i.e., 95 percent Upper Confidence Limit).

Table 3.12-5 Risk of Mercury Baseline Conditions to Aquatic Species in the NGS Near-field and Gap Regions

		NGS Near-field (Lake Powell)		Northeast Gap (Colorado River above Powell)		Southwest Gap (Colorado River below Powell)	
Aquatic Receptors	**Evaluated Medium**	**Hazard Quotient[1]**	**Interpretation**	**Hazard Quotient[1]**	**Interpretation**	**Hazard Quotient[1]**	**Interpretation**
Aquatic community[2]	Surface Water	<1	Negligible risk	<1	Negligible risk	<1	Negligible risk
Benthic community[3]	Sediment	<1	Negligible risk	<1	Negligible risk	<1	Negligible risk
Fish[4]	Fish Tissue	<1	Negligible risk	<1	Negligible risk	>1	Potential risk to adult fathead minnow, rainbow trout, and speckled dace

[1] Hazard quotients based on refined exposure point concentrations evaluated in the NGS Near-field ERA and Gap Region ERA (Ramboll Environ 2016a,c).

[2] The aquatic community, which consists of populations of aquatic plants, invertebrates, amphibians and fish, was evaluated by comparing surface water mercury concentrations to applicable water quality criteria protective of aquatic life.

[3] Benthic invertebrates were evaluated by comparing sediment mercury concentrations to the applicable toxicity threshold protective of sediment-dwelling organisms.

[4] Early life stage (ELS) fish were evaluated by comparing modeled mercury tissue concentrations to the mercury no effect tissue threshold of 0.2 mg/kg wet weight protective of fish health. All other fish (adults/representative fish species) were evaluated by comparing tissue concentrations to the lowest effect threshold (0.77 mg/kg wet weight).

Table 3.12-6 Risk of Selenium Baseline Conditions to Aquatic Species in the NGS Near-field and Gap Regions

		NGS Near-field (Lake Powell)		Northeast Gap (Colorado River above Powell)		Southwest Gap (Colorado River below Powell)	
Aquatic Receptors	**Evaluated Medium**	**Hazard Quotient[1]**	**Interpretation**	**Hazard Quotient[1]**	**Interpretation**	**Hazard Quotient[1]**	**Interpretation**
Aquatic community[2]	Surface Water	=1	Negligible risk	<1	Negligible risk	>1	Potential risk to aquatic community
Benthic community[3]	Sediment	<1	Negligible risk	<1	Negligible risk	<1	Negligible risk
Fish[4]	Fish Tissue	<1	Negligible risk	<1	Negligible risk	>1	Potential risk to adult rainbow trout and speckled dace.

[1] Hazard quotients based on refined exposure point concentrations evaluated in the NGS Near-field ERA and Gap Region ERA (Ramboll Environ 2016a,c).

[2] The aquatic community, which consists of populations of aquatic plants, invertebrates, amphibians and fish, was evaluated by comparing surface water selenium concentrations to applicable water quality criteria protective of aquatic life.

[3] Benthic invertebrates were evaluated by comparing sediment selenium concentrations to the applicable toxicity threshold protective of sediment-dwelling organisms.

[4] Fish were evaluated by comparing selenium tissue concentrations to the selenium no effect tissue threshold of 2 mg/kg wet weight protective of fish health.

Risk to the aquatic and benthic communities under baseline conditions was assessed by comparing current surface water metal concentrations in the water column and in bed sediment, respectively, against appropriate ecological screening values. For evaluation of aquatic communities, unlike most other chemicals, selenium is typically evaluated using total (unfiltered) surface water concentrations (versus dissolved concentrations) because selenium uptake, behavior and toxicity in aquatic systems is highly dependent on site-specific factors, including food web structure and hydrology of the system (USEPA 2015). For this reason, water quality criteria values for selenium promulgated by the USEPA and Navajo Nation were derived on a total (unfiltered) basis and are intended to be compared to total selenium concentrations in surface water. For other chemicals (except aluminum, also evaluated on a total basis), it is the dissolved fraction that is mostly readily taken up and assimilated by aquatic organisms and so dissolved (filtered) results are most applicable. Use of total concentrations for chemicals other than selenium (or aluminum) is conservative and would result in an overestimation of reported risk estimates.

As indicated in **Table 3.12-6**, total selenium concentration in surface water exceeded 1 (refined HQ = 6) in the Southwest Gap, indicating a potential for risk to the aquatic community. It is notable that the refined risk estimate is based on the maximum detected concentration as a 95 percent upper confidence limit could not be calculated for surface water in the Southwest Gap for selenium due to a small dataset; the average concentration also exceeded the criteria. However, no other COPECs exceeded applicable screening levels in any of the other study areas. In the Near-field, the total selenium concentration was equal to the surface water criterion (0.002 mg/L, per Navajo Nation and USEPA). Potential for risk from selenium is not expected however because water criteria are concentrations at or below which effects are not expected – therefore potential risk is considered negligible.

For sediment, the refined HQs were less than 1 for all COPECs in all study areas (**Tables 3.12-5**, **3.12-6**, and **3.12-7**), which indicates that metal concentrations in sediment represent negligible risk to benthic communities as reported in the ERAs (Ramboll Environ 2016a,b,c). The risk characterization and outcome for the fish evaluation is discussed below for each NGS ERA analysis area.

3.12.3.1.5.1 NGS Near-field

The risk characterization for fish under baseline conditions involved evaluation of chemicals in surface water and in fish tissues relative to critical body residues. The critical body residue refined HQs were below 1 for both early life-stage (modeled from surface water only) and adult fish (modeled and measured), which indicates that metal concentrations represent negligible risk to fish. Target fish species used in the measured tissue-based evaluation (data were available for mercury only), consisted of rainbow trout, smallmouth bass, and striped bass. Using literature-based measured mercury concentrations (evaluated as methylmercury) the refined HQs were as follows: rainbow trout (HQ = 0.02), smallmouth bass (HQ = 0.2) and striped bass (HQ = 0.3).

3.12.3.1.5.2 Gap Regions

The Gap Regions consist of two areas in the Colorado River located upstream and downstream of Lake Powell. The Northeast Gap Region extends from the Colorado arm of Lake Powell upstream to the Colorado River confluence with the Green River. The Southwest Gap Region extends from the Glen Canyon Dam downstream in the Colorado River to its confluence with the Little Colorado River.

For the Northeast Gap Region, the risk characterization for baseline conditions indicated that the critical body residue HQs using refined concentrations were below 1 for both early life-stage and adult fish using the 0.2 and 0.77 mg/kg wet weight impact thresholds, respectively. Critical body residue HQs also were calculated based on mercury fish tissue concentrations reported in the literature for the Northeast Gap Region. This analysis showed that refined mercury critical body residue HQs (based on the 0.77 mg/kg wet weight impact threshold) were one to two orders of magnitude below a HQ of 1. The fish species used in the analysis included channel catfish, largemouth bass, and rainbow trout and results were differentiated between fish tissue data obtained from Lake Powell (refined HQ range from 0.1 to 0.2) or the Colorado River (HQ range from 0.04 to 0.4). The overall average refined HQ for all non-native fish species was 0.2

The Southwest Gap Region analysis for baseline conditions indicated risk estimates exceeding 1 suggesting a potential for risk for fish based on exposure to mercury for three fish species (HQ of 2 for fathead minnow, rainbow trout, and speckled dace) and selenium for two fish species (HQ of 2 for rainbow trout and speckled dace). Several other species had refined selenium HQs equal to 1 (carp, fathead minnow, and flannelmouth sucker), whereas a refined mercury HQ equal to 1 was noted for flannelmouth sucker. It is important to note that the HQs equal to or exceeding 1 for the above fish species are based on data from a study by Walters et al. (2015). Recent tissue data resulting from NPS sampling have shown much lower tissue concentrations for rainbow trout consistent with previous studies (Ramboll Environ 2016c), which suggests a lower level risk to non-native fish species. The overall average refined selenium HQ for all non-native fish species was 1 and less than 1 for mercury, indicating that potential risk to the fish community as a whole from these COPECs is negligible.

As indicated, concentrations of COPECs exceeded 1 for risk from selenium exposure to aquatic communities (that includes larval amphibians) and for mercury and selenium exposure to the rainbow trout that serves as a surrogate for the evaluation of adult amphibians. While there may be a potential for risk to adult amphibians with consideration of the rainbow trout results, risk to larval amphibians is not excepted because the surface water concentration was below the chronic (long-term) amphibian-specific screening level for selenium (6.8 µg/L, Sparling et al. 2010). Therefore, negligible risk is expected for larval amphibians under baseline conditions.

3.12.3.1.5.3 San Juan River

The risk of arsenic, mercury and selenium baseline conditions in the San Juan River is summarized in **Table 3.12-7**. The risk characterization for the San Juan River under baseline conditions indicated that the refined critical body residue HQs were below 1 for early life-stage fish (modeled from surface water only). For adult fish (modeled) for mercury, a refined HQ of 1 was noted. However, measured tissue analysis indicated that all concentrations were less than1, indicating that risk is negligible. The selenium evaluation indicated negligible risk to most non-special status fish species. However, refined HQs equal to 1 for selenium were noted for three fish species: speckled dace, red shiner, and mosquitofish. The ERA reported refined HQs less than 1 (indicating negligible risk) for sport fish species including channel catfish, largemouth bass, rainbow trout, and walleye.

Table 3.12-7 Risk from Arsenic, Mercury, and Selenium Baseline Conditions to Aquatic Species in the San Juan River Analysis Area

Aquatic Receptors	Evaluated Medium	Refined Hazard Quotients	Interpretation
Arsenic			
Aquatic community[1]	Surface Water	<1	Negligible risk
Benthic community[2]	Sediment	<1	Negligible risk
Fish [3]	Fish Tissue	<1	Negligible risk
Mercury			
Aquatic community[1]	Surface Water	<1	Negligible risk
Benthic community[2]	Sediment	<1	Negligible risk
Fish [3]	Fish Tissue	=1 (modeled) <1 (sport and non-sport fish)	Negligible risk. Potential for risk based on modeled tissue data (HQ=1); however, risk is considered negligible as HQ<1 for the

Table 3.12-7 Risk from Arsenic, Mercury, and Selenium Baseline Conditions to Aquatic Species in the San Juan River Analysis Area

Aquatic Receptors	Evaluated Medium	Refined Hazard Quotients	Interpretation
			fish community as a whole (all species) and individual species based on measured tissue data.
Selenium			
Aquatic community[1]	Surface Water	<1	Negligible risk
Benthic community[2]	Sediment	<1	Negligible risk
Fish [3]	Fish Tissue	=1 (3 species) <1 (sport and most non-sport fish)	Negligible risk. Potential risk for speckled dace, red shiner, mosquitofish, and striped bass based on HQ=1); however, risk considered negligible as the HQ<1 for the fish community as a whole (all species) based on modeled and measured tissue data.

[1] The aquatic community, which consists of populations of aquatic plants, invertebrates, amphibians and fish, was evaluated by comparing surface water metals concentrations to applicable water quality criteria protective of aquatic life

[2] Benthic invertebrates were evaluated by comparing sediment metals concentrations to the applicable toxicity threshold protective of sediment-dwelling organisms.

[3] Fish were evaluated by comparing metals tissue concentrations to applicable tissue thresholds protective of fish health.

3.12.3.2 Proposed Kayenta Mine Complex

3.12.3.2.1 Habitat

Aquatic habitat within the proposed KMC mainly consists of intermittent and ephemeral streams, springs, and temporary and permanent sediment impoundment ponds. Portions of the Moenkopi and Dinnebito washes, are located within the mine boundary. As of January 2015, it is anticipated that 39 existing sediment retention ponds and 11 internal draining impoundments would remain permanently after mining and reclamation are complete. In the Navajo Aquifer (N-Aquifer) groundwater study area (see Water Resources, Section 3.7.3), additional intermittent streams and springs are present in the N-Aquifer) groundwater study area (**Figure 3.7-3**), including Moenkopi Wash, Dinnebito Wash, Oraibi Wash, Wepo Wash, Polacca Wash, Chinle Wash, Jeddito Wash, Begashibito Wash, Shonto Wash, Laguna Creek, and Cow Springs. Several of the streams such as Moenkopi Wash, Dinnebito Wash, Shonto Wash, Laguna Creek, and Cow Springs, contain water on a more consistent basis as a result of spring input.

3.12.3.2.2 Aquatic Species

The occurrence of fish species within the proposed KMC is limited to a few sediment ponds where fish may be present from unauthorized introductions. For example, sediment pond N14-G contains largemouth bass; however, no public fishing is allowed in the pond. Channel catfish were stocked in Cow Springs in 2015 by the Navajo Nation Division of Fish and Wildlife. Fish species could be present in portions of additional streams or washes that contain water on a more persistent basis. If present, species could include mosquitofish, western killifish, or other species that are adaptable to waterbodies with minimal flow and higher water temperatures.

3.12.3.2.3 Baseline Characterization for Chemicals of Potential Ecological Concern in Surface Water and Sediment

The COPECs that are evaluated for the project are defined in the proposed KMC ERA (Ramboll Environ 2016d). Baseline conditions of aquatic resources within the proposed KMC ERA study area were evaluated based on surface water and sediment data obtained during field sampling in 2014 (Ramboll Environ 2016e,f) and surface water monitoring data provided by Peabody as reported in (Ramboll Environ 2016d). For convenience, data sources for all evaluated media are summarized by medium of interest in Section 3.0.2. Aquatic habitat within the study area consists of ponds (constructed sediment control structures), springs, and ephemeral streams. The geology of the region (dominated by the Wepo Formation) results in enrichment of surface water by some metals such as aluminum, boron, cadmium, manganese, selenium, and vanadium, which may become entrained in silts and clays carried in runoff during precipitation events (rain, snowmelt) and deposited in receiving waters (Ramboll Environ 2016d). Runoff provides recharge to groundwater (percolation from the surface downward into groundwater) and/or is collected in sediment control structures that manage runoff from active mine areas. Natural enrichment of metals from geological formations and soils may lead to groundwater concentrations within the formation that are in excess of aquatic life criteria and/or domestic drinking water standards in areas where there is connection to surface water (Ramboll Environ 2016d).

The proposed KMC ERA specifically evaluated aquatic biological resources represented by the aquatic community and benthic community only. Fish were not specifically addressed as a separate assessment endpoint at the proposed KMC (as was done at NGS and associated study areas) because such populations are limited or absent due to intermittent nature of streams/washes, low flow and/or limited extent of springs, and small extent and/or intermittent nature of most ponds. Although some ponds are known to contain introduced fish, these populations are limited in abundance and diversity and are present in only a few of the larger permanent ponds (Ramboll Environ 2016d). Fish are evaluated as a component of the aquatic community. For the aquatic community evaluation, refined HQs exceeded 1 for several metals in sediment control structures (aluminum, manganese, and selenium), springs (cadmium, manganese, and selenium) and/or streams (aluminum and manganese). Hazard quotients greater than 1 indicate that a potential risk to aquatic species is possible and indicates that additional evaluation considering other lines of evidence may be warranted to draw conclusions. For the benthic community, all sediment concentrations were below applicable screening levels with refined HQs less than 1 indicating a negligible risk. Although the HQs exceed 1 for some metals for aquatic community receptors, negligible effects to aquatic or benthic species from baseline metal concentrations are anticipated because the aquatic/benthic species that are present in these waterbodies have adapted to the local (natural) hydrogeologic conditions within the proposed KMC ERA analysis area, which is a conclusion in the proposed KMC ERA (Ramboll Environ 2016d).

3.12.3.3 Transmission Lines and Communication Sites

3.12.3.3.1 Habitat

Streams provide perennial habitat within the transmission line ROW as listed below.

- WTS – Colorado River, Paria River, Antelope Creek, Gypsum Wash, Muddy River, Virgin River, Las Vegas Wash, and Meadow Valley Wash; and
- STS – Agua Fria River, Big Bug Creek, and Verde River.

3.12.3.3.2 Aquatic Species

Sport fish species are known to occur in several of the larger streams crossed by the transmission lines such as the Colorado, Muddy, Virgin, and Verde rivers. Sport fish species in the Colorado River are listed in **Table 3.12-2** for the Southwest Gap Region. Sport species in the Verde River include largemouth bass, smallmouth bass, sunfishes, crappies, and channel catfish (Arizona Game and Fish Department 2015b). Streams crossed by the ROWs also contain aquatic invertebrates. However, no specific sport fish occurrence, abundance, or habitat quality data were collected for the streams crossed by the transmission line ROWs because this type of information is not necessary for the impact analysis of operation and maintenance activities. There would be no construction disturbance for the transmission lines.

No perennial habitat occurs at the communication sites; therefore, fish are not expected to be present and no further analysis was conducted.

3.12.4 Environmental Consequences

3.12.4.1 Issues

3.12.4.1.1 Navajo Generating Station

Issue 1 – Emissions and Deposition - aquatic habitat located within the NGS Near-field ERA, Gap Regions, and the San Juan River ERA areas was analyzed for emission and deposition effects on water quality, aquatic species, and fish tissue.

Issue 2 – Water Use - NGS future use of cooling water drawn from Lake Powell could cause decreases in storage water volume in the lake and result in changes to pool levels and potentially affect aquatic species. Future water withdrawal through the intake could result in entrainment and impingement effects on fish species

Issue 3 – Effects of Implementation of Fish Conservation Measures - effects of implementing fish conservation measures on aquatic species in the San Juan River and Colorado River below Glen Canyon Dam.

3.12.4.1.2 Proposed Kayenta Mine Complex

Issue 1 – Operations and Reclamation - effects of mine disturbance on aquatic species and habitat

Issue 2 – Realignment of Navajo Route 41 - effect of realigning Navajo Route 41 on aquatic species and habitat.

Issue 3 – Emissions and Deposition - potential impacts of emission and deposition caused by NGS and proposed KMC combined future operations were analyzed for effects on water quality, aquatic plants, invertebrates, and fish. The study area was discussed above in baseline characterization and in the proposed KMC ERA (Ramboll Environ 2016d).

Issue 4 – Groundwater Pumping - effects of groundwater pumping on surface water and aquatic species.

3.12.4.1.3 Transmission Systems and Communication Sites

Issue 1 – Operation and Maintenance - effects of operation and maintenance of transmission systems on perennial streams and aquatic species crossed by the WTS and STS.

3.12.4.2 Assumptions and Impact Methodology

The following information provides a description of the assumptions, project-committed protection measures, and methodologies that were used for aquatic biological resources.

3.12.4.2.1 Assumptions

- Aquatic species or groups analyzed in the ERAs include plants, invertebrates (both water column and bottom-dwelling species), fish, and amphibians throughout the overall study area. The emphasis in this EIS on fish is for sport species due to their recreational importance. Other fish species are included in the ERA analyses due to their role in the aquatic food chain or other ecological roles such as competition for habitat or food.

- The overall study area was divided into three project components: NGS, proposed KMC, and the transmission systems and communication sites. Within each project component, the potential impact of the project actions were analyzed, as discussed below in the various subsections.
- Assumptions used in the emission and deposition analyses are described in the ERAs (Ramboll Environ 2016a,b,c,d).
- Surrogate species identified in the ERAs are representative of species that occur in the analysis area. Surrogates included representatives for fish, macroinvertebrates, and amphibians.
- Potential surface disturbance from operation and maintenance activities could occur within the WTS and STS ROWs. However, there would be no direct disturbance within perennial stream channels crossed by the WTS and STS.

3.12.4.2.2 Methods

3.12.4.2.2.1 Emissions and Deposition

- Three ERAs were conducted to analyze the effects of NGS emissions and the resulting deposition of chemicals on ecological receptors in Lake Powell (NGS Near-field ERA), the Colorado River above and below Lake Powell (Gap Regions ERA), and the San Juan River (San Juan River ERA) (Ramboll Environ 2016a,b,c). A separate fate and transport study was conducted by the EPRI (2016) to assess the impact of mercury, selenium, and arsenic emissions from regional power plants (i.e., NGS, Four Corners Power Plant, and San Juan Generating Station) on federally endangered fish in the San Juan River and to provide quantitative data to estimate the contributions and impacts of other local, regional, and long-range contributions. Results from the EPRI study were used to develop the San Juan River and Gap Regions ERAs. Details describing the methodologies for the ERAs are provided in **Appendix 3RA**, Ecological and Human Health Risk Assessment.
- The methodologies for selecting the study areas for each of the ERAs (Ramboll Environ 2016a,b,c) are provided in **Appendix 3RA**, Ecological and Human Health Risk Assessment.
- The timeframe for impact analysis on aquatic (and terrestrial) communities was from 2020 – 2074. The additional 30 years of analysis following NGS shut down in 2044 was included to assure that the deposition from NGS and proposed KMC had sufficient time to move through the terrestrial landscapes into watersheds and through aquatic systems (see EPRI 2016).
- Ecological risk was calculated for baseline conditions, proposed project impacts, and cumulative impacts. The values are assessed independently (as explained above in baseline evaluations) and combined together to assess overall total risk to aquatic receptors.
- Ecological risk was determined for the aquatic receptors in terms of a quantitative and/or qualitative estimate of ecological risks, based on the potential exposure of a representative receptor to a COPEC present in abiotic media (e.g., soil, surface water, sediment) and in biotic media consumed by the receptor (e.g., plants, invertebrates) relative to defined toxicity data. Ecological risk was determined by calculating HQs for community-based receptors representing the aquatic community and dose-based receptors for higher trophic levels. Detailed information on how HQs were calculated and what the number means is provided in **Appendix 3RA**, Ecological and Human Health Risk Assessment. The refined HQ value, which was calculated by comparing the 95 percent upper confidence limit concentration (where available) for each COPEC, is considered to be the most realistic prediction of ecological risk rather than maximum concentrations. This is because receptors are unlikely to be exposed to the highest levels of all COPECs at all times. If the refined HQ is less than 1, there would be negligible ecological risk to aquatic species or community. If the refined HQ is 1 or greater, ecological risk was evaluated using other lines of information to draw conclusions regarding the potential for risk.

- The effects assessment for aquatic species consists of two types of effects metrics: surface water ecological screening values and critical body residues expressed as concentrations of mercury and selenium estimated in whole body invertebrate and fish tissue. Fish tissue-based critical body residues are used as the effects metrics for the measurement endpoint of fish tissue chemistry (i.e., concentrations of mercury and selenium reported in published literature). Fish tissue-based critical body residues reflect the bioavailable fraction of mercury and selenium and include exposures across multiple pathways such as respiration transfer, sediment ingestions, and diet.
- Impacts on aquatic species or species groups also were evaluated in terms of the comparisons to relative population numbers to determine the context of the impact. This consideration of impact context was then used to determine the relative magnitude of the impact. Impacts to resources may fit five categories: none, negligible, minor, moderate, and major. These categories are defined in Section 3.0 of this EIS.

3.12.4.2.2.2 NGS Water Use

- Water level changes in Lake Powell that exceed 1 foot in pool elevation could alter the amount of aquatic habitat in bays or other shallow areas.
- Results from NPS (2007) are used in this EIS to assess entrainment and impingement effects.

3.12.4.2.2.3 Effects of Implementation of Fish Conservation Measures

- Actions involving the control of non-native fish and translocation of razorback sucker in the Colorado River below Lake Powell and transfer of listed fish and habitat enhancement in the San Juan River were analyzed in a qualitative manner by relating the conservation measures actions to general aquatic communities.

3.12.4.2.2.4 Proposed KMC Operations and Reclamation

- Known or potential occurrence of fish was evaluated for mining areas in a qualitative analysis.
- Waterbodies located within the footprint of mine disturbance were identified as aquatic habitats that could be affected by mining activities.

3.12.4.2.2.5 Realignment of Navajo Route 41

- Perennial waterbodies within the footprint of road realignment disturbance area were identified as aquatic habitats that could be affected by road construction and realignment.

3.12.4.2.2.6 Proposed KMC Deposition and Emissions

- Previous baseline studies and the proposed KMC ERA field studies were used to identify aquatic habitat, water, soil, and sediment quality conditions in those habitats, and species within the mining area.

3.12.4.2.2.7 Proposed KMC Groundwater Pumping

- Mine well pumping was modelled to determine potential effects on groundwater and connected surface waters, ultimately affecting fish habitat and species.

3.12.4.2.2.8 Transmission Systems Operations/Maintenance

- It was assumed that perennial streams crossed by the transmission lines would support aquatic species. Perennial streams that intersect the WTS and STS transmission system ROWs were evaluated for operation and maintenance activities in a qualitative analysis. Potential effects to perennial streams crossed by the WTS and STS ROWs could occur if vehicles or equipment disturb soils within 500 feet of the ROW boundaries.

- No perennial stream habitat is located at the communication sites and so no further analysis was conducted for this project component.

3.12.4.2.3 Project Best Management Practices and Protection Measures

Best Management Practices (BMPs) and protection measures that are part of the NGS-KMC Project would be implemented to avoid or reduce impacts to aquatic habitat and species as detailed below.

3.12.4.2.3.1 Navajo Generating Station

- Maintenance of a Spill Prevention, Control, and Countermeasure Plan that contains measures used to prevent oil discharges from occurring and actions for responding to a spill in an effective and timely manner to mitigate the impacts of any discharge to a navigable water. Actions in the Spill Prevention, Control, and Countermeasure Plan include preventative maintenance of equipment and containment and discharge prevention systems; annual employee training; and monthly inspections.
- During repairs and maintenance of project infrastructure, standard BMPs would be used to prevent degradation of surface waters (i.e., spill prevention and capture plans, storm water runoff controls, silt fencing and straw bales, and sediment and erosion controls) would be implemented.
- An ash landfill berm would be used to capture and prevent stormwater runoff.
- Construction, operations, and maintenance activities would be scheduled as feasible to minimize work during periods when the soil is too wet to support construction equipment, which could cause deep ruts, road degradation, and surface disturbance.
- Zero liquid discharge facility would be used.
- Implementation of the Groundwater Protection Plan and compliance with CCR regulations would be used to assure protection of the N-Aquifer.

3.12.4.2.3.2 Proposed Kayenta Mine Complex

- Sediment control and revegetation would be done as part of the Environmental Protection Standards and Reclamation Plan in the KMC Mine Permit.
- Maintenance of a Spill Prevention, Control, and Countermeasure Plan that contains measures used to prevent oil discharges from occurring and actions for responding to a spill in an effective and timely manner to mitigate the impacts of any discharge to navigable waters.
- Stormwater runoff BMP’s and National Pollutant Discharge Elimination System water control structures to reduce/eliminate pollution from entering receiving streams.
- Soil erosion and sediment control BMPs.

3.12.4.2.3.3 Transmission Systems and Communication Sites

- Biologically sensitive areas identified by the USFWS and other federal land managers would be mapped prior to maintenance activities. Appropriate measures would be implemented to avoid and/or minimize impacts to known populations of federally listed or other special status species.
- Conservation measures would be implemented on Forest System lands to minimize impacts to federally listed species and their critical habitat. Aquatic species would include loach minnow, Gila topminnow, and Gila chub. The relevant National Forest crossed by the STS is Coconino.
- Standard BMPs involving spill prevention and capture, stormwater runoff control, and erosion control would be implemented during repairs to prevent degradation of surface waters.

- Staging areas for loading and unloading equipment would be located in previously disturbed areas and outside of floodplains and wet areas.
- All applicable labels, federal and state laws, and regulations with regard to the use and application of herbicides would be strictly adhered to avoid effects to the environment.
- All herbicide applications would be spot treatments utilizing backpack, handheld, and quad/all-terrain vehicle mounted sprayers with plant specific treatment.
- There would be no new roads or ground disturbing activities.
- If a portion of the transmission line is inaccessible by road or sensitive habitats occur within the ROW, the crew would drive to the nearest location and walk to the site with the necessary equipment.
- Vegetation management would not widen the ROW corridor.
- Existing established roads would be used to access powerline ROWs.
- Where vehicle access is not available crews would hike in from the nearest access point.
- During repairs and maintenance of project infrastructure, standard BMPs to prevent degradation of surface waters (i.e., spill prevention and capture plans, storm water runoff controls, silt fencing and straw bales, and sediment and erosion controls) would be implemented.
- Staging areas for loading and unloading of equipment would be located in previously disturbed areas, but outside of floodplains and other wet areas.

3.12.4.3 Proposed Action

3.12.4.3.1 Navajo Generating Station

3.12.4.3.1.1 Emissions and Deposition

Potential effects of power plant emissions and deposition on aquatic species in Lake Powell, the Colorado River, and the San Juan River.

A summary of the ERAs conducted for the project, including the contribution of NGS emissions/deposition of metals (and other chemical constituents) on aquatic biological resources, is provided in **Appendix 3RA**, Ecological and Human Health Risk Assessment. Detailed methods, supporting information, and results are provided in the ERA reports (Ramboll Environ 2016a,b,c).

<u>NGS Near-field Study Area</u>

The study area for the Near-field ERA was a 20-kilometer (km) radius from NGS, which captured a portion of Lake Powell and that portion of the Colorado River below Glen Canyon Dam that lies within the 20-km study area (**Figure 3.12-1**). The information in **Table 3.12-8** describes the estimated ecological risk of metals emitted and deposited within the near-field from NGS in combination with baseline conditions in Lake Powell on aquatic species in Lake Powell. The overall timeframe of 2020 to 2074 was analyzed to account for the “lag period” between closure of NGS in 2044 and movement of COPECs through the environment (watersheds and food web).

Table 3.12-8 NGS Near-field ERA Potential Impacts of Mercury and Selenium Emissions and Deposition from Baseline Conditions and NGS on Aquatic Species, 2020 – 2074

Aquatic Receptors	Evaluated Medium	3-Unit Operation		2-Unit Operation	
		Refined Hazard Quotients	**Interpretation**	**Refined Hazard Quotients**	**Interpretation**
Aquatic community[1]	Surface water	<1	NGS emissions in combination with baseline conditions would represent a negligible risk to water-column aquatic community, benthic invertebrates or fish in Lake Powell.	<1	Negligible risks to aquatic and benthic communities, fish, and amphibians, but this operation would contribute lower emissions and deposition than the 3-Unit Operation.
Benthic community[2]	Sediment	<1		<1	
Fish[3]	Fish Tissue	<1		<1	
		<1			

[1] The aquatic community, which consists of populations of aquatic plants, invertebrates, amphibians and fish, was evaluated by comparing surface water metals concentrations to applicable water quality criteria protective of aquatic life.

[2] Benthic invertebrates were evaluated by comparing sediment metals concentrations to the applicable toxicity thresholds protective of sediment-dwelling organisms.

[3] Fish were evaluated by comparing metals tissue concentrations to applicable tissue thresholds protective of fish health.

Source: Ramboll Environ 2016a.

Refined HQs were less than 1 for dissolved and total metal concentrations in surface water (protective of aquatic communities), as well as for tissue-based metal concentrations for both early life-stage fish and adult fish. For example, refined tissue-based HQs for non-native fish species (rainbow trout, striped bass and smallmouth bass) were well below 1 ranging from 0.0002 for the 2-Unit Operation to 0.0003 for the 3-Unit Operation. The combination of Proposed Action emissions/deposition with baseline conditions resulted in refined HQs for mercury ranging from about 0.02 to 0.3 for non-native fish species, with an HQ of 0.2 considering all non-native species (average of species data). Therefore, the proposed future operations of NGS (3-Unit Operation or 2-Unit Operation) and the estimated emissions and deposition of metals (including mercury and selenium) to Lake Powell and surrounding watershed, would represent a negligible effect to aquatic communities, sediment communities, and fish species in Lake Powell and that portion of the Colorado River below Glen Canyon Dam that lies within the 20-km analysis area.

Northeast Gap Region

The study area for the Northeast Gap Region extended from the Colorado River inflow area to Lake Powell to the confluence with the Green River. A summary of the Gap Regions ERA is provided in **Appendix 3RA**, Ecological and Human Health Risk Assessment and detailed methods and results are provided in the ERA report (Ramboll Environ 2016c). **Table 3.12-8** summarizes the outcome of the ERA for aquatic species in the Colorado River upstream of Lake Powell in the Northeast Gap. The results consider the contribution from NGS emissions/deposition from the 3-Unit Operation and 2-Unit Operation in combination with baseline results for the COPECs identified as a potential concern to aquatic biological resources: mercury and selenium.

The contribution of the NGS 3-Unit Operation or 2-Unit Operation alone would represent a negligible risk to aquatic species in the Northeast Gap Region. Refined HQs were less than 1 for all evaluations and COPECs identified previously for the Northeast Gap region, which included assessment of the aquatic community, sediment community, and fish (early life-stage and adult fish). Potential for risk from baseline in combination with NGS 3-Unit Operation or 2-Unit Operation results in HQs below 1 indicating negligible effects to aquatic biological resources.

Southwest Gap Region

The study area for the Southwest Gap Region extended from extent of the 20-km radius Near-field study area (below Glen Canyon Dam) downstream to the confluence with the Little Colorado River. **Table 3.12-9** summarizes the ERA results for aquatic species in the Colorado River downstream of Lake Powell. The results consider the contribution from NGS emissions/deposition from the 3-Unit Operation and 2-Unit Operation in combination with baseline results for the COPECs identified as a potential concern to aquatic biological resources: mercury and selenium.

The contribution of Proposed Action operations alone would represent a negligible risk to aquatic species in the Colorado River downstream of Lake Powell from metal concentrations. Refined HQs based on NGS operations were less than 1 for all evaluations and COPECs identified previously for the Southwest Gap Region, which included assessment of the aquatic community, sediment community, and fish (early life-stage and adult fish). Baseline results indicate potential for risk from selenium (HQ=6) for aquatic community receptors based on comparison of the total (unfiltered) selenium concentration to water quality criteria protective of aquatic life. However, the 3-Unit Operation (maximum production scenario) contributes a very small percentage (less than 1 percent) to the total HQ for selenium indicating that baseline conditions account for the majority of reported risk. For the sediment evaluation, HQs for both NGS emission scenarios were well below 1 for all COPECs. The impact is considered to be minor because the number of individuals that could be injured would represent a small portion of the overall population numbers for these species.

Table 3.12-9 Gap Regions ERA Potential Impacts of Metal Emissions and Deposition from Baseline Conditions and NGS on Aquatic Species, Years 2020 – 2074

Aquatic Receptor	Evaluated Medium	3-Unit Operation		2-Unit Operation	
		Refined Hazard Quotients	Interpretation	Refined Hazard Quotients	Interpretation
Southwest Region (Colorado River downstream of Lake Powell)					
Aquatic Community	Surface water	<1	Direct contact with water and sediment from NGS emissions in combination with baseline conditions do not pose a risk to aquatic or benthic communities.	<1	Negligible risks to aquatic and benthic communities, but this operation would contribute lower emission levels and deposition.
Benthic Community	Sediment	<1		<1	
Fish	Fish Tissue	Mercury and selenium refined critical body residue HQs >1 for some non-special status species.	Potential risk to several non-special status fish species due to baseline measured (literature-derived) fish tissue concentrations that exceed critical body residues. However, negligible risk to the fish community as a whole. Future NGS emissions and deposition would contribute a very small addition to baseline fish tissue concentrations (less than 1%).	Mercury and selenium refined critical body residue HQs >1 for several non-special status species (HQs range from 1 to 2).	Potential risks to several non-special status fish species, contributed almost entirely from baseline. However, negligible risk to the fish community as a whole. Future project operations would contribute a small fraction to the existing conditions.
Northeast Region (Colorado River upstream of Lake Powell)					
Aquatic Community	Surface water	<1	NGS emissions in combination with baseline conditions would not represent a potential impact to aquatic or benthic communities or fish in the Colorado River upstream of Lake Powell.	<1	Negligible risks to aquatic and benthic communities and fish, Future project operations would contribute a small fraction to the existing conditions.
Benthic Community	Sediment	<1		<1	
Fish	Surface water, food	<1		<1	

Source: Ramboll Environ 2016c.

For the evaluation of fish, based on literature-derived tissue concentration comparison to critical body residues, NGS 3-Unit Operation and 2-Unit Operation alone showed negligible risk to non-native fish because HQs were well below 1 for all COPECs. When combining baseline conditions with NGS emissions scenarios, there would be potential risks to fathead minnow, rainbow trout, and speckled dace from mercury exposure (HQ of 2 for all); and carp, fathead minnow, flannelmouth sucker, rainbow trout, and speckled dace from selenium (HQs ranging from 1 to 2). The 3-Unit Operation contributes a very small percentage (less than 1 percent) to the total HQ for mercury and selenium, indicating that baseline conditions account for the majority of reported risk. The impact level is considered to be minor because the potential injury effects to these species would be a very small percent of their overall population numbers in the Southwest Gap Region.

<u>San Juan River</u>

The study area for the San Juan River extended from the State Route 371 Bridge in Farmington, New Mexico, downstream to the San Juan arm of Lake Powell. A summary of the San Juan River ERA is provided in **Appendix 3RA**, Ecological and Human Health Risk Assessment and detailed methods and results are provided in the ERA report (Ramboll Environ 2016b). **Table 3.12.10** summarizes the ERA results for aquatic species in the San Juan River. The results consider the contribution from NGS emissions/deposition from the 3-Unit Operation and 2-Unit Operation in combination with baseline results for the COPECs identified as a potential concern to aquatic biological resources: mercury and selenium.

The contribution of Proposed Action operations alone would represent a negligible risk to aquatic species in the San Juan River from metal concentrations. Refined HQs were less than 1 for all evaluations and COPECs identified previously for the San Juan River (baseline), which included assessment of the aquatic community, sediment community, and fish (early life-stage and adult fish). Potential for risk from baseline in combination with NGS 3-Unit Operation or 2-Unit Operation resulted in negligible risk to the aquatic community and sediment community. In addition, there would be a negligible risk to sport fish and most of the other non-native fish from selenium, based on refined critical body residue-based HQs being 1 or less than 1. A refined HQ of 1 was noted for three non-native fish species (speckled dace, red shiner, and mosquitofish) when combining NGS emissions with baseline fish tissue concentrations. However a HQ of 1 to individual species does not indicate potential risk to the community as whole and therefore potential risk to the fish community is considered negligible. The 3-Unit Operation contributes a very small percentage (less than 1 percent) to the total HQ for selenium indicating that baseline conditions account for the majority of reported risk. The impact level would be considered minor because a very small percent of their overall population numbers in the San Juan River would be affected.

3.12.4.3.1.2 Water Use

If the project is authorized, NGS would be allocated to withdraw up to 40,000 acre-feet per year. Historical use has been 34,100 acre-feet per year. Under a 3-Unit Operation, water use is expected to be 26,000 to 29,000 acre-feet/year within the same range as historical operations. With the installation of SCRs for nitrogen oxide emission control, additional water would be required, but the total withdrawal volume would not exceed 34,100 acre-feet per year. Under a 2-Unit Operation or curtailed generation due to Best Available Retrofit Technology, water withdrawal would be approximately one-third of the 3–Unit Operation (i.e., 8,580 to 9,570 acre-feet less withdrawal). The estimated change in pool level from the 3-Unit Operation and 2-Unit Operation would be extremely small (less than 0.1 foot). The small increase from the 2-Unit Operation or decrease from the 3-Unit Operation in pool elevation would not change the aquatic habitat to the extent that it would affect fish or invertebrate composition or abundance (**Table 3.12-11**). It is important to note that the Lake Powell pool elevation fluctuates annually and seasonally based on inflow and water releases. The pool elevation can rise more than 10 feet in a relatively short period of time.

Table 3.12-10 San Juan River ERA Potential Impacts of Metal Emissions and Deposition from Baseline Conditions and NGS on Aquatic Species, 2020 – 2074

Aquatic Receptor	Evaluated Medium	3-Unit Operation		2-Unit Operation	
		Refined Hazard Quotients)	Interpretation	Refined Hazard Quotients	Interpretation
Aquatic Community	Surface water	<1	NGS emissions in combination with baseline conditions would represent negligible risks to aquatic or benthic communities in the San Juan River.	<1	2-Unit Operation would result in HQ values approximately 20 to 40 percent less than the 3-Unit Operation (depending on the metal) HQ. NGS emissions in combination with baseline conditions and other cumulative emissions would represent negligible effects to aquatic or benthic communities in the San Juan River.
Benthic Community	Sediment	<1	Negligible risk; refined (and maximum) HQ<1.	<1	Negligible risk; refined (and maximum) HQ<1.
Fish	Fish Tissue	Selenium refined critical body residue HQs =1 for some non-special status species	Negligible risk for non-special status fish critical body residue from mercury and selenium.	<1	Negligible risk; HQ for fish would be less than the 3-Unit Operation.
Amphibians	Surface water	None	Negligible risk to amphibians from mercury, arsenic, and selenium.	None	Negligible risk to amphibians from mercury, arsenic, and selenium.

Source: Ramboll Environ 2016b.

Table 3.12-11 NGS Water Use Impacts on Aquatic Biological Resources

Water Use Impacts – 3-Unit Operation	Water Use Impacts – 2-Unit Operation
Pool elevation would decrease less than 0.1 foot, if 34,100 acre-feet are withdrawn from Lake Powell.	Pool elevation would increase less than 0.1 feet, if 8,540 to 9,570 acre-feet less water are withdrawn from Lake Powell.
No change in fish or invertebrate composition or abundance would occur due to the slight reduction in habitat.	No change in fish or invertebrate composition or abundance would occur due to the slight increase in habitat.

The continuation of water withdrawals through the intake system would occur for both the 3-Unit Operation and 2-Unit Operation. There would be a minor effect of the water intake system on the entrainment or impingement of fish, as discussed in NPS (2007). The basis for this conclusion is that the intake system is in a deep portion of the lake where fish numbers are relatively low.

3.12.4.3.1.3 Effects of Implementation of Fish Conservation Measures

Implementation of conservation measures for federally listed fish species in the Southwest Gap Region (Colorado River below Lake Powell) and the San Juan River would result in both negative and beneficial impacts to non-special status fish species. Detailed descriptions of these measures are provided in Section 2.3.1.3. Measures are analyzed for non-special status species as listed below.

- Southwest Gap Region - FS-1 (Non-native Fish Management in the Colorado River Grand Canyon Area) and FS-2 (Razorback Sucker Translocations).
- San Juan River - FS-4 (Support Transport of Colorado Pikeminnow and Razorback Sucker Above the Waterfall Barrier in the San Juan River) and FS-5 (Funding Support for a Habitat Improvement Project in the San Juan River).

<u>FS-1</u>

Implementation of FS-1 would result in the emergency treatment of warmwater non-native fish species in response to invasions of non-native fish in areas that are negatively affecting the federally listed humpback chub and razorback sucker. The removal of non-native fish at selected sites would result in a reduction in non-native fish numbers. The target species or groups would be channel catfish, black bullhead, striped bass, trout, and sunfishes. FS-1 would result in a negative effect on the targeted non-native fish species; however, there would be a beneficial effect on native fish species by removing predation and competition factors. The beneficial effect on native fish species at treatment sites would likely result in increased numbers.

<u>FS-2</u>

The translocation of razorback sucker into areas not presently occupied by this species would have minor effects on other aquatic species. If razorback sucker inhabits a new area, the species would compete with other fish species that feed on invertebrates and plant material. The additional competition for these food sources is not expected to negatively affect other fish species, because these food sources are considered to be abundant throughout the Southwest Gap Region.

<u>FS-4</u>

The transport of Colorado pikeminnow and razorback sucker above the waterfall in the San Juan River would allow these species to utilize habitat throughout the San Juan River. Both species would compete for food sources with other fish species. As previously mentioned, razorback sucker consume invertebrate and plant material, which are considered to be abundant throughout the San Juan River. Colorado pikeminnow is a predator at the juvenile and adult stage, with the predominant food consisting soft-rayed fishes, including bluehead sucker, flannelmouth sucker, red shiner, sand shiner, and fathead minnow. There could be a reduction in numbers for these fish species in areas where Colorado pikeminnow are more concentrated. However, when considering that pikeminnow are very mobile, the overall effect on other fish species would be considered minor.

FS-5

Habitat enhancements in the San Juan River would create additional habitat for federally listed species as well as other non-native and native fish species. This measure would be beneficial to aquatic species in general, because it would enhance existing habitat in the river.

3.12.4.3.2 Proposed Kayenta Mine Complex

3.12.4.3.2.1 Operations and Reclamation

Mining would occur in mining units N-9, N-10, N-11 Extension, J-19, J-21, and J-21W under the 3-Unit Operation. New sediment ponds are proposed for N-10, N-11 Extension, and J-21W as part of mining. These three mining units would contain a total of 28 sediment ponds. Under the 2-Unit Operation, mining unit N-10 would be eliminated, which would reduce the number of sediment ponds to 21. Three ephemeral stream segments also are located within two of the mining units: Red Peak Valley Wash in J-19 and Sagebrush Wash and Yucca Flat Wash in J-21W. The ephemeral streams would provide habitat for invertebrate species when water is present. Aquatic species in these ponds would likely consist of water column invertebrates and algae as well as bottom-dwelling invertebrates. No fish are known to occur in these ponds. During mining, the ponds would receive runoff that could contain higher levels of suspended particulates for a short-term basis. It is expected aquatic species in the ponds would be able to tolerate temporary fluctuating levels of suspended sediment. After mining is completed, the ponds would be removed. Mining in J21W would disturb the upper portions of three ephemeral stream segments, which would remove marginal aquatic habitat that is not available on a consistent basis. Low quality habitat would be affected by sediment input during mining and eventually removed as part of reclamation. The effect of mine disturbance would be considered minor because of the types of marginal habitat that would be affected as well as the lack of sport fish or other important aquatic species. The effects of proposed KMC under the 8.1 million tons per year (tpy) and 5.5 million tpy plans generally would be the same for aquatic species because the number of sediment ponds and stream segments are very similar (**Table 3.12-12**).

Table 3.12-12 Impacts to Aquatic Species from Mining Disturbance

	NGS 3-Unit Operation		NGS 2-Unit Operation	
Parameter	**Number**	**Impact Conclusion**	**Number**	**Impact Conclusion**
Number of Proposed Sediment Ponds	28	Minor effects because sediment input to ponds during mining that are considered low quality aquatic habitat, and marginal amount of aquatic habitat would be permanently removed due to mining.	21	Minor effects because sediment input to ponds during mining that are considered low quality aquatic habitat, and marginal amount of aquatic habitat would be permanently removed due to mining.
Number of Stream Segments within Mining Units	3		3	

3.12.4.3.2.2 Realignment of Navajo Route 41

Surface disturbance within or near the pond located adjacent to the Navajo Route 41 realignment could increase sedimentation and turbidity. The pond contains warmwater fish species. The effects from input to this pond would range from effects on species behavior and physiological functions to activities such as spawning (Waters 1995), depending on the species. In general, many of the warmwater fish species are tolerant of moderate levels of suspended sediment concentrations on a temporary basis. The duration of sediment effects would be short-term in relation to the short timeframe of road construction. The effect from road construction would be the same for both the 3-Unit Operation and 2-Unit Operation.

Implementation of the applicant-committed environmental protection measures for erosion control as well as state and federal regulatory requirements would serve to reduce impacts to aquatic species in the sediment pond. The impact would be considered minor due to the small amount of sediment input and the marginal quality of aquatic habitat in the ponds.

3.12.4.3.2.3 Emissions and Deposition

The study area for the proposed KMC includes the current Kayenta Mine lease property boundary and proposed expansions. In addition, several locations adjacent but outside of the lease boundary associated with special status species occurrence also are included in the overall study area. A summary of the proposed KMC ERA is provided in **Appendix 3RA**, Ecological and Human Health Risk Assessment and detailed methods and results are provided in the ERA report (Ramboll Environ 2016d). As indicated in Section 3.12.2, the proposed KMC ERA specifically evaluated aquatic biological resources represented by the aquatic community and benthic community only. The aquatic ecological receptors within the study area for the proposed KMC ERA are provided in **Table 3.12-13** along with HQ results and impact conclusions based on two future scenarios. The results consider the contribution from surface disturbance from mining activities associated with coal resource yields of 8.1 million tons per year and 5.5 million tpy, which represent the quantity of coal needed to support NGS 3-Unit Operation and 2-Unit Operation, respectively.

The contribution of the 8.1 million tpy and 5.5 million tpy operations alone would represent a negligible risk to aquatic species at the proposed KMC. For the benthic community potential risk is not expected as all sediment concentrations were below applicable screening levels, as indicated by refined HQs less than 1. Although baseline HQs exceeded 1 for some metals for aquatic community receptors, no effect to aquatic community receptors from baseline metal concentrations are anticipated because observed concentrations are comparable to reference locations (ponds) and the aquatic species that are present in these waterbodies are adapted to the local (natural) hydrogeologic conditions and flow regimes within the proposed KMC ERA study area, which is supported by the conclusion of the proposed KMC ERA (Ramboll Environ 2016d). Potential risk to aquatic biological resources is considered negligible.

3.12.4.3.2.4 Groundwater Pumping

Groundwater modeling was conducted to evaluate the effects of mine well pumping on groundwater and connected surface water sources. Details on the groundwater modeling analysis and results are provided in Section 3.7, Water Resources. The modeling analysis investigated potential changes in groundwater contributions to seven streams including Begashibito, Chinle, Dennebito, Jeddito, Moenkopi, and Polacca washes and Laguna Creek. When comparing the simulated stream baseflows for 1956 to those of 2019, modeling results estimated that the maximum decrease in 2019 simulated baseflow would be less than 0.04 cubic feet per second from all previous project groundwater pumping. Over the projected 2020 through 2057 pumping period, the total 3-Unit Operation pumping would be approximately 1,200 acre-feet/year through 2044 and approximately 100 to 500 acre-feet/year through 2057, which is reduced from previous rates, comprising 20 percent of the historic Peabody Western Coal Company pumping volume. It is important to note that the pumping analysis extends until 2110 so that the maximum drawdown effect is determined. There is a continued effect beyond the end of pumping.

Table 3.12-13 Proposed KMC ERA Potential Impacts on Aquatic Species for All COPECs

Representative Ecological Receptor	Evaluation Medium	8.1 Million tpy KMC Mine Plan		5.5 Million tpy KMC Mine Plan	
		Refined Hazard Quotients	Interpretation	Refined Hazard Quotients)	Interpretation
Aquatic Community	Surface water	>1	Negligible risk to aquatic and benthic communities and fish from COPECs. All reported HQs noted for aquatic community attributable to background conditions.	<1	Negligible risk to aquatic and benthic communities from COPECs. This option would contribute lower level of emissions and deposition.
Benthic Community	Sediment	<1		<1	
Fish	Fish Tissue	<1		<1	

Refer to Section 3.7, Water Resources, for additional detail on the groundwater pumping analysis. Based on the future total withdrawal due to proposed project pumping, no measurable change in 2019 stream baseflows are predicted by the model from pumping for either Proposed Action operation (3-Unit Operation and 2-Unit Operation). Therefore, the proposed KMC pumping for operations from 2020 to 2054 would not result in direct or indirect effects to aquatic habitat or species in streams with connections to groundwater.

Groundwater modeling also was conducted for eight geographical groups of springs to determine if project pumping could affect spring outflows. Details for this analysis are provided in Section 3.7, Water Resources. The model results predicted that spring flow reduction from project groundwater pumping could occur in three of the spring groups (in locales near Tuba City/Moenkopi Wash, Chinle, and Dennehotso). The model analysis estimated small flow reductions from less than 0.001 to about 0.06 gallons per minute. For most spring groups, simulated changes in hydraulic head (water level at the ground surface) generally ranged from zero to about 0.01 or 0.02 feet. Immediately west of Chinle, the head change ranged up to about 0.1 foot. These small changes in conditions at some springs would represent a small loss of aquatic habitat from proposed project pumping. The effect of a potential small reduction of flow input or water levels in a few springs would not be expected to affect invertebrate species that likely inhabit springs.

3.12.4.3.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

3.12.4.3.3.1 Operations and Maintenance

Activities for the WTS and STS transmission lines would involve inspection and minor maintenance (Category A) and routine maintenance (Category B) within the ROWs. Maintenance activities also would occur if there is equipment failure. Surface disturbance could be substantial only for the Category B activities as a result of equipment use and vehicles. Vegetation clearing would be completed by hand or mechanical methods for the Category A activities; mechanical and herbicide treatment would be used for Category B activities on some row segments. Surface disturbance activities near streams that are crossed by the transmission ROWs could result in sediment or spill risks, which could affect habitat for aquatic species. Sport fish species occur in the larger streams such as the Colorado, Paria, Verde, Muddy, and Virgin rivers.

If O&M activities occur near streams crossed by the transmission line ROWs, aquatic habitat could be affected for a short-term duration as a result of potential sediment input. The extent of the area affected would depend on the type of soil composition and characteristics of the stream or standing waterbody (e.g., flow conditions, channel or waterbody morphology, presence of aquatic vegetation, and gradient). Typically, the extent of downstream movement of sediment is less during low flow conditions and more extensive during high flow conditions. However, the suspended sediment levels would be more diluted under high flow conditions due to the higher water volume.

Increases in sediment entering a stream can adversely affect physiological processes for aquatic species or alter habitat conditions. Suspended sediment can affect physiological functions such as oxygen uptake for aquatic species. Depending on the sediment level and sensitivity of the species, effects can range from reduced health to mortality (Waters 1995). Sediment levels can bury invertebrate and early life stages of fish. Sedimentation can affect fish habitat by covering spawning and rearing areas, thereby reducing the survival of fish embryos and juvenile fish. Excessive sedimentation also can fill in pool habitats and blanket structural cover for fish. Pool habitats provide important depth cover and overwintering habitat.

Vehicle and equipment use adjacent to streams and waterbodies also could pose a risk to aquatic biota from fuel spills or lubricant leaks. If fuel were to reach a waterbody, aquatic species could be exposed to toxic conditions. Impacts could include direct mortalities or reduced health of aquatic organisms. The magnitude of a potential spill would depend on the flow conditions, channel or waterbody morphology and gradient, and the response time and effectiveness of containment and cleanup operations.

Vegetation treatment involving herbicides would not affect aquatic species because chemicals that are nontoxic to fish and amphibian species would be approved for use. All herbicide treatments would be applied as specified by the chemical label, state laws, federal land policies, manuals, and guidelines. In general, BMPs that would minimize effects to aquatic species and their habitats would include selecting herbicides with the least effect on waterbodies, using buffer areas, applying herbicides during calm weather conditions, using spot application versus broadcast application, and focusing on protection of waterbodies containing fish or other aquatic species.

Applicant-committed protection measures would be implemented to avoid or reduce impacts to aquatic habitat and species within the transmission line ROWs. A summary of these measures is provided below. Additional detail is provided in Section 3.13.4.1.

- Biologically sensitive areas identified by the USFWS and other federal land managers would be mapped prior to maintenance activities.
- Standard BMPs involving spill prevention and capture, stormwater runoff control, and erosion control would be implemented during repairs to prevent degradation of surface waters.
- Staging areas for loading and unloading equipment would be located in previously disturbed areas and outside of floodplains and wet areas.

When considering applicant-committed protection measures at all perennial stream crossings by the transmission line ROWs, impacts to aquatic species and habitat would be reduced to a low level for a short-term duration. There would be no direct alteration or loss of habitat for aquatic species. As such, impacts are anticipated to be negligible.

3.12.4.3.4 Project Impact Summary – All Project Components

NGS emissions and deposition by itself would represent a negligible risk to aquatic and benthic communities, fish, and amphibians in the overall study area (NGS Near-field study area, Northeast Gap Region, Southwest Gap Region, and San Juan River), as indicated by refined HQs that are orders of magnitude less than 1. When combining NGS emissions with baseline conditions, there would be a negligible risk to aquatic and benthic communities, amphibians, and most fish species in the study area, based on the HQ values less than 1. There would be potential risk to several non-special status fish species from selenium in the Southwest Gap Region and the San Juan River, based on HQs greater than 1. The impact level would be considered minor for these species because the few species potentially negatively affected and the relative small effect on overall population numbers. There would be negligible risks and effects to aquatic species in the NGS Near-field and Northeast Gap Region for NGS emissions in combination with baseline conditions.

The analysis for the proposed KMC also supported a conclusion of minor risk to aquatic species, primarily as a result of groundwater pumping. Proposed KMC emissions under the 8.1 million tpy and 5.5 million tpy plans would not directly, negatively affect aquatic species. The combination of the two mining plans with baseline conditions indicated that there is a minor effect to aquatic communities due to total concentrations of aluminum and selenium, and dissolved concentrations of cadmium and manganese in surface water that exceed toxicity thresholds protective of aquatic life. Refined HQs exceeded 1 in surface water for aluminum, cadmium, manganese and selenium.

However, aquatic species that occur in the proposed KMC area are generally tolerant of these water and sediment conditions. Project pumping in the proposed KMC would result in small flow reductions, which represents minor effect on aquatic species. It also is important to note that aquatic habitat in the proposed KMC is marginal quality due to the lack of perennial streams and use of sediment ponds as part of sediment control rather than the purpose of developing aquatic resources.

The other project component, transmission systems and communication sites, also supports the conclusion of minor effects on aquatic species. By implementing BMPs, operation and maintenance activities would result in negligible effects on stream water quality or habitat.

3.12.4.3.5 Cumulative Impacts

The following discussion is divided into emission and deposition effects followed by other cumulative effects on aquatic species for the portions of the overall study area related to each of the analysis areas.

3.12.4.3.5.1 Navajo Generating Station Emissions and Deposition

The cumulative impact involving emissions and deposition for aquatic biological resources is the contributions of baseline conditions, NGS stack emissions of trace metals, and other cumulative emission sources that are combined to provide an estimate of tissue concentrations in non-special status species within the various impact study areas. The ERA models were used to provide estimated concentrations of the various COPECs. As indicated in **Table 3.12-14**, emissions from NGS future operation under the Proposed Action would result in deposition of trace metals that contributes a small fraction of the total cumulative tissue concentrations in non-special status fish species. The cumulative effects on aquatic species would vary depending on the ERA analysis areas. Total cumulative emissions in the NGS Near-field and Northeast Gap ERAs indicated negligible risk to aquatic species from mercury and selenium under baseline conditions. Total cumulative emissions of mercury and selenium in the Southwest Gap ERA represent a potential risk to fish species from mercury and selenium. Baseline conditions are the main contributor to metal effects. Total cumulative emissions in the San Juan ERA indicated no potential risks to fish species from mercury or selenium.

Table 3.12-14 Measured Fish Tissue Concentrations (Refined) for Adult Non-Special Status Species and Relative Contribution of NGS Operations to Total Cumulative Sources, 2020 – 2074

		NGS Operations (µg/kg wet weight)			Total Cumulative (µg/kg wet weight)		NGS Operations Percent of Total	
COPEC[1]	**Baseline[2] (µg/kg wet weight)**	**2 Unit**	**3-Unit**	**Other Cumulative Sources (µg/kg wet weight)**	**2 Unit**	**3-Unit**	**2 Unit**	**3-Unit**
San Juan River								
Arsenic[3]	210	0.086	0.086	11.4	221.5	221.5	0.04%	0.04%
Mercury[3]	73	0.235	0.235	103.2	176.1	176.1	0.13%	0.13%
Selenium	1,110	0.159	0.235	36.6	1,146.8	1,146.8	0.01%	0.02%
Northeast Gap								
Arsenic	*210*	0.00333	0.00460	0.00110	210.0	210.0	<0.01%	<0.01%
Mercury	129	0.210	0.312	315.7	444.9	445.0	0.05%	0.07%
Selenium	*328*	0.046	0.068	0.0103	328.1	328.1	0.01%	0.02%

Table 3.12-14 Measured Fish Tissue Concentrations (Refined) for Adult Non-Special Status Species and Relative Contribution of NGS Operations to Total Cumulative Sources, 2020 – 2074

COPEC[1]	Baseline[2] (µg/kg wet weight)	NGS Operations (µg/kg wet weight)		Other Cumulative Sources (µg/kg wet weight)	Total Cumulative (µg/kg wet weight)		NGS Operations Percent of Total	
		2 Unit	3-Unit		2 Unit	3-Unit	2 Unit	3-Unit
Southwest Gap								
Arsenic	*238*	0.00333	0.00455	0.00004	238.0	238.0	<0.001%	<0.002%
Mercury	8	0.375	0.562	1236	1244.8	1,245.0	0.03%	0.05%
Selenium	2,350	0.351	0.520	0.004	2,350.4	2,350.5	0.01%	0.02%
NGS Near-field								
Arsenic	*174*	0.0137	0.0185	0.0000058	174.0	174.0	<0.01%	0.01%
Mercury	133	0.175	0.216	42.5	175.7	175.7	0.10%	0.12%
Selenium	*400*	0.149	0.261	0.000052	400.1	400.3	0.04%	0.07%

[1] The critical body residue thresholds applied for adult fish are: arsenic (5,500 µg/kg); mercury (770 µg/kg wet weight); and selenium (2,000 µg/kg wet weight). Concentrations presented are based on the average of the refined tissue concentrations for all fish species for which data were available.

[2] Baseline values presented in italicized text indicate measured tissue data were not available; concentrations were based on modeled results using site-specific uptake factor and surface water concentration.

[3] For the 2-Unit Operation, arsenic and mercury concentrations were less than the 3-Unit Operation but extremely small and below the computational limit of the EPRI (2016) model, and so could not be calculated. Therefore, tissue concentrations for the 3-Unit Operation were conservatively used for the 2-Unit Operation.

NGS Near-field Study Area

The cumulative analysis showed that the combination of NGS 3-Unit Operation and 2-Unit Operation and other cumulative emissions with baseline conditions resulted in refined HQs less than 1 for all COPECs. The cumulative effects analysis showed that refined HQs were one to ten orders of magnitude less than 1, which indicates there would be negligible risk to aquatic species.

Potential risk to amphibians was evaluated qualitatively using water quality criteria protective of aquatic communities and toxicity literature for amphibians (Sparling et al. 2010). The primary food source for amphibians is insects, so exposure to COPECs would be via pathways similar to those evaluated for fish such as trout; a portion of diet also may come from terrestrial sources. When considering the refined concentrations of COPECs, HQs for fish (and aquatic communities) were below 1. There would be negligible risk expected for amphibians under baseline conditions or with the addition of NGS or other cumulative emissions.

In summary, HQs for all of the aquatic receptors and individual species were less than 1 for all metals when using refined values for NGS 3-Unit Operation and 2-Unit Operation in combination with baseline conditions, and other cumulative emissions. The conclusion of the NGS Near-field ERA analysis is that the NGS emissions likely would not represent a potential risk to water-column invertebrates, plants, amphibians, benthic invertebrates, and fish in Lake Powell. No additional lines of evidence were required because all HQs were less than 1.

The slight reduction in Lake Powell elevation from NGS water use would combine with other cumulative actions involving the operation of Lake Powell and water withdrawals from Lake Powell for the Lake Powell Pipeline. Because the NGS water use would represent less than 1 percent of the total cumulative change in Lake Powell volume and Colorado River flows, the project contribution to cumulative effects would be minor. Additional discussion of cumulative effects from the long-term operation of Glen Canyon Dam is provided in the Southwest Gap Region section.

Based on the SECURE Water Act Report (Reclamation 2011) and Reclamation and NPS (2015), climate changes in the Colorado River Basin include the following:

- Colorado River Basin temperature is projected to increase by an average of 5 to 6ºF during the 21st Century;
- Precipitation is expected to increase by 2.1 percent in the upper basin and decline by 1.6 percent in the lower basin;
- Mean annual runoff is projected to decrease by 3.5 to 8.5 percent by 2050; and
- Warmer conditions might cause changes in fisheries habitat, shifts in species geographic ranges, increased water demands for instream ecosystems and thermoelectric power production, increased power demands for municipal uses (including cooling) and increased likelihood of invasive species infestations. Endangered species issues might be exacerbated although warmer water may increase spawning success for native species.

Increases in the water temperature of Colorado River mainstem and its tributaries in Grand Canyon due to climate change could expand the distribution of warmwater-adapted non-native fishes (Eaton and Scheller 1996; Rahel and Olden 2008), which can prey on and compete with native fishes such as endangered humpback chub or disadvantaged coldwater non-native species.

Northeast Gap Region

The cumulative emissions analysis showed that the combination of NGS 3-Unit Operation and 2-Unit Operation with baseline conditions and other cumulative emissions in the Northeast Gap Region resulted in refined HQs less than 1 for all COPECs. The cumulative effects analysis showed that refined HQs were 1 to 6 orders of magnitude less than 1, which indicates there would be negligible risks to aquatic species.

In summary, the Northeast Gap Region analysis indicated that the NGS emissions in combination with baseline conditions and other cumulative emissions would not represent potential risks to water-column invertebrates, plants, amphibians, benthic invertebrates, and fish in the Colorado River upstream of Lake Powell. Hazard quotients for all of the aquatic receptors and individual species receptors were less than 1 for all COPECs when using refined values for baseline conditions in combination with NGS 3-Unit Operation and 2-Unit Operation, and other cumulative emissions. No additional lines of evidence were required because all HQs were less than 1.

Climate change and water diversions in the Upper Colorado Basin would contribute additional effects to aquatic species in the Northeast Gap Region. Currently, the magnitude of global climate change is such that its effect on freshwater fisheries and other aquatic species could easily be masked by or attributed to other anthropogenic causes such as overexploitation, deforestation, and land use (Ficke et al. 2007).

Southwest Gap Region

The cumulative emissions analysis for the Southwest Gap Region showed that the combination of NGS 3-Unit Operation and 2-Unit Operation with other cumulative emissions and baseline conditions in the Southwest Gap Region would represent potential risks to some fish species from selenium and mercury. The effect would be related to fish critical body residues for mercury and selenium, as indicated by HQs slightly above 1 (highest refined HQ=3) for individual fish species based on measured tissue data, although risk from both metals is considered negligible for risk results based on modeled metals results (mercury adult and early life stage HQs less than 1, and selenium HQ equal to 1) and measured mercury and selenium in fish tissue that consider the fish community as a whole (fish average, HQ equal to 1). The effect to individual species primarily would be caused by baseline conditions with a smaller contribution from other cumulative actions. These HQs indicate that mercury and selenium represent potential risks to some fish species in the Southwest Gap Region.

In summary, the Southwest Gap Region analysis indicated that direct contact with water and sediment under a combination of baseline conditions with NGS and other cumulative emissions would represent negligible risks to water-column invertebrates and plants, benthic invertebrates, amphibians, and most fish species in the Colorado River downstream of Lake Powell. However, mercury and selenium represent potential risks to several non-special status fish species, as indicated by critical body residue HQs exceeding 1 using refined concentrations. This risk is due to baseline conditions and to a lesser extent, other cumulative emissions; NGS emissions would contribute a very small amount to the baseline conditions for mercury and selenium.

Five additional sources have been identified, which have the potential to contribute to cumulative impacts in the Southwest Gap Region. These include climate change, Lake Power operations, non-native fish threats, mining, and other human activities.

Climate Change – The effect of climate change on water temperatures and flows in the Colorado River below Lake Powell is the same as discussed for the Northeast Gap Region.

Lake Powell Operations – The long-term operation of Glen Canyon Dam would result in effects on aquatic communities in the Colorado River (Reclamation and NPS 2015). The Preferred Alternative analyzed in the *Long-term Experimental and Management Plan Draft EIS* would result in slightly higher productivity of benthic invertebrates in the nearshore portion of the lake and in the river below the dam and negligible change in trout population numbers. There would be a decrease in trout recruitment as a result of reduced trout spawning habitat, which would be beneficial to native fish. There would be a potential increase in warmwater non-native fish habitat due to more uniform monthly releases. There also would be a slight increase in average temperature suitability for non-native fish.

Non-native Fish Threat – The implementation of FS-1 as part of the Proposed Action would result in the emergency treatment of warm-water non-native fish species in response to invasions of non-native fish in areas that are negatively affecting the federally listed humpback chub and razorback sucker. The removal of non-native fish at selected sites would result in a reduction in non-native fish numbers. The project effect would be in combination and support eradication and removal efforts for non-native fish species, as defined in the Grand Canyon Fisheries Management Plan (NPS 2013). These cumulative actions would reduce non-native fish numbers at selected sites and benefit native fish in the Colorado River below Lake Powell.

Mining – Based on a renewed interest in uranium, there could be increased mining on lands that drain into the Colorado River, which could increase the amount of uranium, arsenic, and other trace elements in local surface water and groundwater. Aquatic species and habitat most likely to be affected by mining would be those associated with small ephemeral and intermittent streams. A spill of uranium ore or other mining material that reached a perennial stream could affect water quality in the Colorado River. However, the timing and extent of such an accidental spill is unpredictable, and spill control and containment requirements would likely minimize any long-term effect on fish species or their habitat.

Human Activities – The increase in recreation activities involving fishing, boating, camping, and vehicle use would result in angling pressure, non-point pollution, fire threat, introduction of non-native fish species, and potential disturbance to native fishes.

Six additional sources have been identified, which have the potential to contribute to cumulative impacts in the San Juan River area. These include climate change, water diversions, the San Juan River Basin Recovery Implementation Program, Four Corners Power Plant Operations, non-native fish threats, and other human activities.

The cumulative emissions analysis for the San Juan River showed that the combination of the Proposed Action operations and other cumulative emissions with baseline conditions would represent negligible risks to aquatic species from mercury and arsenic. Other cumulative sources added 30 to 90 percent to the mercury dissolved concentrations, although HQs remained below 1 (i.e., negligible risk). The ERA results indicate no potential risks to fish as fish tissue HQs were 1 or below 1 for each species evaluated, with baseline conditions contributing most to total cumulative risk HQs.

Other Cumulative Actions

Climate Change – Climate change may have contributed to additional depletions to the San Juan River. The magnitude and timing of the depletions cannot be predicted with certainty at this time. Several studies project a decrease in stream flow from eight to 45 percent depending on the model used, the time frame, and the methods (Christensen and Lettenmaier 2007; Hoerling et al. 2013; Ray et al. 2008; Seager et al. 2007; Udall 2007). Although the San Juan River was not modeled independent of the entire Colorado River basin in these studies, based on the projections of the Intergovernmental Panel on Climate Change (Christensen et al. 2007) for warmer temperatures and an increase in the frequency of hot extremes and heat waves, it is reasonable to expect that there will be a decrease in stream flow in the future. The analysis of Bluff river flow gaging data indicates an annual reduction of some 9,200 acre-feet per year as a long-term linearized trend in the San Juan River basin. This pattern is consistent with the data for the Colorado River Basin; however, the reductions as a percent of the annual total is double that of the Colorado River (0.44 percent per year, versus 0.22 percent per year for the Colorado River). Although the year-to-year variability is substantial, the ongoing reduction in river flows at this site is clear. Changes in flow patterns or flow volumes could affect key biological activities such as fish spawning and early stage development of eggs and young fish, as well as increasing the colonization of non-native or invasive aquatic species (Garfin et al. 2013). Higher air temperatures also may increase the water temperatures resulting in local range expansions for species that can adapt to higher water temperatures. Higher water temperatures also could cause positive or negative changes in food supply for fish by affecting invertebrate development (Garfin et al. 2013).

Water Diversions – Cumulative water diversions would include coalbed methane development, irrigation/canal withdrawals, livestock grazing, and water use for urban development. Other foreseeable non-federal Colorado San Juan River drainage water storage projects (documented by applications to the Colorado State Engineer) include the Long Hollow Reservoir (proposed capacity of 5,300 acre-feet) and the Dry Gulch Water Storage Project (proposed capacity of 11,000 acre-feet). These projects could contribute to cumulative reductions in Navajo Reservoir River storage, which could influence the volume of water available for release for fish habitat maintenance purposes.

San Juan River Basin Recovery Implementation Program – The San Juan River Basin Recovery Implementation Program was established in 2000 and continues to be implemented for the purpose of assisting in the recovery the Colorado pikeminnow and the razorback sucker while allowing water development and management activities to continue in the San Juan River Basin. Program elements consist of protection of genetic integrity and augment Colorado pikeminnow and razorback sucker populations and their habitat; water quality protection and enhancement; management of native and non-native fish species; and data management. Activities implemented by the San Juan River Basin Recovery Implementation Program provide beneficial effects to aquatic species. One program element, control of non-native fish, has resulted in reduction in numbers of selected fish species at selected sites.

Four Corners Power Plant Operations – Conservation measures implemented for the operation of the Four Corners Power Plant involve habitat improvements and removal of non-native fish species for the purpose of benefitting Colorado pikeminnow and razorback sucker. These measures would combine with the NGS-KMC Proposed Action and the San Juan River Basin Recovery Implementation Program. Emission and deposition effects from the Four Corners Power Plant were included in the emission and deposition cumulative analysis discussed above.

Non-native Fish Threat – A future threat of non-native fish movement from Lake Powell could occur during wet years when the waterfall barrier is inundated. Striped bass, channel catfish, walleye, and other non-native fish species would move into to the San Juan River and compete with Colorado pikeminnow and razorback sucker for food sources and habitat.

Human Activities – The increase in recreation activities involving fishing, boating, camping, and vehicle use would result in angling pressure, non-point pollution, fire threat, introduction of non-native fish species, and potential disturbance to native fishes.

3.12.4.3.5.2 Proposed Kayenta Mine Complex

The combination of NGS and proposed KMC emissions under the 3-Unit Operation and 2-Unit Operation together with other cumulative emission sources and baseline conditions would represent a potential for impacts to aquatic receptors exposed to total concentrations of aluminum and selenium, and dissolved concentrations of cadmium and manganese in surface water. The potential risk or effect from these metals would be due to baseline conditions which contributes the majority of the risk to aquatic receptors. The proposed future KMC emissions by themselves would not contribute to the potential metal effects on aquatic species.

The overall cumulative effect of groundwater pumping in the N-Aquifer area would be substantial in Polacca and Chinle washes and Laguna Creek with reductions in annual flow of 32 to 48 percent of 2020 rates. These reductions would substantially reduce the amount of aquatic habitat in these washes where surface water is present and cause reductions in the abundance and diversity of aquatic invertebrates and plants. The cumulative effect is caused by pumping activities other than the proposed project. The project would contribute to a future reduction in baseflows in these drainages after 2020 of 0.7 percent to 0.9 percent based on the results of the groundwater modeling.

3.12.4.3.5.3 Transmission Systems and Communication Sites

The minor effect on aquatic species in perennial streams crossed by the Proposed Action would combine with other cumulative actions consisting of the Transwest Express Transmission Project, Southern Nevada Intertie, and the Lake Powell Pipeline for the WTS. These projects are briefly described in Section 3.0 of this EIS. Future road use and recreation activities also could disturb areas adjacent to perennial streams crossed by both the WTS and STS. Total cumulative actions would potentially affect habitat in 11 perennial streams located within the ROWs. The project contribution to overall cumulative impacts would be minor, because activities would be limited to operation and maintenance activities with limited disturbance, and inspection activities would occur infrequently (ordinarily 2 times a year on the WTS and STS).

3.12.4.4 Natural Gas Partial Federal Replacement Alternative

This discussion focuses on the impacts to aquatic species from reducing the power generated at NGS, with consequent reductions in coal production at the Kayenta Mine. There is limited discussion of the alternative site because it is assumed that surface water and perennial waterbodies would be limited when considering the arid characteristics of region.

Under the Natural Gas PFR Alternative, a selected quantity of power between 100 megawatts (MW) and 250 MW would be contracted for under a long-term power purchase agreement from currently unidentified, existing natural gas generation sources, displacing an equivalent amount of power from the federal share of NGS generation. Because the facility is assumed to currently exist, prior disturbance impacts to aquatic biological resources are not evaluated. Key assumptions about aquatic biological resources related to such an existing site are listed below.

- A combined-cycle natural gas power plant would typically be located on a site of approximately 100 acres. No additional surface disturbance would be required over time.
- Potential surface disturbance could occur at scattered locations within the entire site.
- Perennial waterbodies are assumed to be limited within the alternative site due to the arid characteristics of the general region.
- Natural gas combustion to generate power would not result in deposition to surface water of the trace metal associated with coal combustion under the Proposed Action. This difference in emissions is addressed in the Air Quality resource section.

Impact issues for this PFR Alternative are discussed across the range of NGS unit operations (3-Unit and 2-Unit) and associated alternative power reductions (100 MW and 250 MW) from the least NGS power reduction to the greatest. Reductions in NGS power generation would proportionally reduce the quantity of coal delivered from the Kayenta Mine.

The focus of this discussion is to distinguish differences in impacts within the replacement alternative operational range to provide a basis for comparison with the Proposed Action.

3.12.4.4.1 Navajo Generating Station

The following information describes impacts to aquatic species for the Natural Gas PFR Alternative. This alternative would reduce the power output at NGS for the 3-Unit Operation and 2-Unit Operation by 100 MW to 250 MW due to alternative power purchased from an unknown source at an existing site. Because the site is assumed to be an existing facility, prior disturbance and associated impacts to aquatic species are not evaluated in this EIS.

3.12.4.4.1.1 Emissions and Deposition

The Natural Gas PFR Alternative would result in the following percent reductions in power output for the 100-MW and 250-MW replacements in comparison to the Proposed Action: 5 and 13 percent for the 3-Unit Operation and 8 and 19 percent for the 2-Unit Operation. The reduction in power output would result in less coal burned and lower deposition of metals and other COPECs in the portions of the study area analyzed for NGS and associated facilities (i.e., NGS Near-field, Northeast Gap Region of the Colorado River, Southwest Gap Region of the Colorado River, and the San Juan River) when compared to the Proposed Action. As a result of lower deposition of metals, the reported risk indicator or HQ for aquatic species would be slightly reduced in each of the analysis areas. For example, a comparison of the mercury HQs for the Proposed Action and a modeled 1,400-MW scenario using ERA analyses (Ramboll Environ 2016c) showed a very small reduction in adult sport fish HQ values (**Table 3.12-15**). The 1,400-MW scenario was modeled for the ERA to depict a data point between the values presented for the smallest change (3-Unit Operation/100-MW Replacement) and largest change (2-Unit Operation and 250-MW Replacement). A similar slight reduction in mercury and selenium HQs is shown for other aquatic groups such as water column plants and invertebrates and benthic invertebrates. The point of this comparison is show that there would be a very slight reduction in risk to aquatic species from mercury or selenium under this alternative for both the 3-Unit Operation and 2-Unit Operation. The risk resulting from this Natural Gas PFR Alternative would negligible for the 3-Unit Operation and 2-Unit Operation, which is the same as discussed for the Proposed Action.

The combination of this PFR Alternative with baseline conditions would represent potential risks to several non-special status fish species in the San Juan River and Southwest Gap Region of the Colorado River, because HQs are greater than 1. The potential risk is dictated by baseline fish tissue concentrations from mercury and selenium rather than the project contribution under the PFR

Alternative. Species that would be affected include rainbow trout, fathead minnow, mosquitofish, and redside shiner. The impact level would be considered minor, because the injury effect or potential loss of individuals from mercury or selenium tissue concentrations would be small and within the natural population variability over the 2020 to 2074 timeframe of the project.

Table 3.12-15 Comparison of Mercury Hazard Quotients in Adult Fish Tissue

ERA Analysis Areas / Species	Proposed Action 3-Unit Operation	Proposed Action 2-Unit Operation	1,400-MW ERA-modeled Scenario *
Northeast Gap Region			
Sport fish species (average)	0.0004	0.0003	0.0002
Southwest Gap Region			
Sport fish species (average)	0.0007	0.0005	0.0002
San Juan River			
Sport fish species (average)	0.0002	<0.0002	<0.0002

* Source: Ramboll Environ (2016b,c) ERAs.

3.12.4.4.1.2 Water Use

The effects of NGS water use on aquatic species under this alternative would be negligible, as described for the Proposed Action. Water use would result in very small change in the water levels in Lake Powell and the Colorado River below Glen Canyon Dam.

3.12.4.4.1.3 Effects of Implementation of Fish Conservation Measures

The effects of implementing the conservation measures for federally listed species in the San Juan River and Colorado River below Lake Powell on aquatic species would be the same as described for the Proposed Action. Effects of the FSs are summarized as follows:

- FS-1 (Non-native Fish Management in the Grand Canyon Grand Canyon Area) – This measure would result in reduced numbers for species or groups such as black bullhead, channel catfish, striped bass, trout, and sunfishes in treatment areas. There would be a beneficial effect on native fish species in the treatment areas by reducing predation and competition factors.
- FS-2 (Razorback Sucker Translocations) – This measure could result in minor effects on aquatic species in areas where razorback sucker are translocated as a result in feeding in invertebrates and plant materials.
- FS-4 (Transport of Colorado Pikeminnow and Razorback Sucker above the Waterfall Barrier in the San Juan River) – The transport of these species into areas above the waterfall barrier would result in competition for food sources with other fish species. Razorback sucker would reduce invertebrate numbers and plant debris in areas. Colorado pikeminnow feeds on fish species such as bluehead sucker, flannelmouth sucker, red shiner, sand shiner, and fathead minnow, which could result in reduced numbers at scattered locations. The effects would be minor when considering the mobility of Colorado pikeminnow and razorback sucker and the abundance of food sources.
- FS-5 (Funding Support for a Habitat Improvement in the San Juan River) – This measure would be beneficial to aquatic species in general, because it would enhance existing habitat in the river.

3.12.4.4.2 Proposed Kayenta Mine Complex

The following discusses the impacts to aquatic biological resources if 100 MW to 250 MW of power generation were replaced at NGS by alternative sources and the proposed KMC would mine less coal 8.1 million tpy production (NGS 3-Unit Operation) and 5.5 million tpy production (NGS 2-Unit Operation). Under the Renewable PFR, alternative power would be purchased by Reclamation from an unknown, but existing source. Therefore, prior disturbance impacts to aquatic biological resources are not evaluated.

3.12.4.4.2.1 Operations, Reclamation, and Realignment of Navajo Route 41

The Natural Gas PFR Alternative would result in minor effects on aquatic species and habitat within the proposed KMC as a result of mining and surface disturbance. The effect is considered minor due to the relatively small amount of potential sediment input to sediment ponds and intermittent streams within the mining and road alignment areas. The affected habitat also is considered to be marginal quality because the ponds are not used for the development of fish populations and the intermittent streams lack flow during most of the year.

3.12.4.4.2.2 Emissions and Deposition

Proposed KMC emissions under the Natural Gas PFR Alternative would be reduced as a result of less coal being burned. There would be a slight reduction in risks to aquatic species as indicated by slightly lower HQs. The combination of proposed KMC emissions under this alternative with baseline conditions would represent negligible risks, as although HQs for some metals were greater than 1 for the aquatic community, the observed concentrations were comparable to reference locations (ponds), and the aquatic species that are present in these waterbodies are adapted to the local (natural) hydrogeologic conditions and flow regimes within the proposed KMC ERA study area (Ramboll Environ 2016d). All HQs were less than 1 for benthic community and fish evaluations. The impact level would be considered minor to aquatic and benthic communities, fish, and amphibians based on the low level risks. Effects from this alternative would be the same as described for the Proposed Action.

3.12.4.4.2.3 Groundwater Pumping

Groundwater pumping would be the same as the Proposed Action, with less than 1 percent potential reduction in stream and spring flows. This small change would represent a negligible effect to northern leopard frog habitat.

3.12.4.4.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

3.12.4.4.3.1 Operations and Maintenance

There would be negligible impacts to the existing transmission systems and communication sites because no changes in the operations of the WTS, STS, or communications sites would occur due to the implementation of the Natural Gas PFR Alternative. Impacts would be negligible to fish species that occur in streams crossed by the WTS and STS, as described for the Proposed Action. BMPs and applicant-committed protection measures would be implemented to reduce impacts to a negligible level for special status fish species.

3.12.4.4.4 Project Impact Summary

In summary, the Natural Gas PFR Alternative would result in 5 to 19 percent power reduction compared to the Proposed Action, which would result in lower emissions and deposition of metals within the study area. As a result of lower deposition of metals, the risk indicator or HQ for aquatic species would be slightly reduced in each of the study areas compared to the Proposed Action. NGS emissions under this alternative by themselves represent a negligible risk on all species, as indicated by the very small HQ values. The combination of NGS emissions and baseline conditions also would represent negligible risks to aquatic species in the study area, as indicated by the HQs being less than 1 for NGS and baseline emissions. The effects of the Natural Gas PFR Alternative on the aquatic community, benthic invertebrates, and most fish species would be negligible, based on the low number of individuals that could be injured and the small percentage of population numbers potentially affected. There would be potential risks and minor effects on individual fish species in the Southwest Gap Region and San Juan River (e.g., rainbow trout, fathead minnow, mosquitofish, and redside shiner). The impact level would be considered minor because the injury effect or potential loss of individuals from mercury or selenium tissue concentrations would be small and within the natural population variability.

The effects of NGS water use would result in negligible effects on aquatic species in Lake Powell and the Colorado River below Lake Powell.

Implementation of conservation measures for federally listed species would result in both minor negative and beneficial effects on aquatic species in the San Juan River and Colorado River below Lake Powell depending on the measure.

In terms of the analysis for the proposed KMC, there would be negligible effects from metals on aquatic species from overall cumulative emissions. Groundwater pumping for the KMC Proposed Action would contribute less than 0.1 percent reduction in Begashibito Wash flow.

The operation and maintenance of the transmission systems would result in negligible effects on special status species, because access road use and potential vegetation treatment would be short-term in duration and limited in terms of surface disturbance. By following BMPs for operation and maintenance activities in combination with additional conservation measures, effects on species and their habitat would be minimized.

3.12.4.4.5 Cumulative Impacts

The combination of NGS and proposed KMC emissions under the Natural Gas PFR Alternative plus other cumulative deposition sources would result in the same total cumulative emission effects as described for the Proposed Action. The only difference is that the NGS contribution to total cumulative emissions would be slightly less compared to the Proposed Action, as indicated by slightly lower HQs. However, the project risk and contribution is so small that it does not change the overall effects to aquatic species. The effects on the special status aquatic species are dictated by baseline fish tissue concentrations and deposition from other cumulative sources. Risks and effects would negligible to aquatic species in the NGS Near-field and Northeast Gap Region of the Colorado River. Risks and effects to water column plants and invertebrates, benthic invertebrates, and most fish species in the Southwest Gap Region of the Colorado River and the San Juan River also would be negligible, as indicated by HQs below 1. There would be potential risks and minor effects on fish species such as rainbow trout, fathead minnow, mosquitofish, and redside shiner. The impact level would be considered minor, because the injury effect or potential loss of individuals from mercury or selenium tissue concentrations would be small and within the natural population variability.

Other cumulative actions that would adversely affect aquatic species and their habitat in the NGS Near-field are in Lake Powell, San Juan River, Northeast Gap Region, and Southwest Gap Region include climate change, water use, urban development, mining, and other human activities such as recreation. These activities and effects on aquatic species would be the same as discussed in the Proposed Action cumulative impact discussions for the San Juan River and humpback chub for the Southwest Gap Region.

Cumulative effects of the Natural Gas PFR Alternative in combination with other cumulative actions in the proposed KMC and transmission system areas would be the same as discussed in the Proposed Action cumulative impacts sections.

3.12.4.5 Renewable Partial Federal Replacement Alternative

Under the Renewable PFR Alternative, a selected quantity of power between 100 MW and 250 MW would be contracted for under a long-term power purchase agreement from a currently unidentified, existing renewable energy power source, displacing an equivalent amount of power from the federal share of NGS generation. Therefore, prior disturbance impacts to aquatic biological resources are not evaluated.

3.12.4.5.1 Navajo Generating Station

3.12.4.5.1.1 Emissions and Deposition

The Renewable PFR Alternative would result in the following percent reductions in power output for the 100-MW and 250-MW replacements in comparison to the Proposed Action: 3 and 7 percent for the 3-Unit Operation and 4 and 11 percent for the 2-Unit Operation. The reduction in power output would result in less coal burned and lower deposition of metals and other COPECs in the portions of the study area analyzed for NGS and associated facilities (i.e., NGS Near-field, Northeast Gap Region of the Colorado River, Southwest Gap Region of the Colorado River, and the San Juan River) when compared to the Proposed Action. As a result of lower deposition of metals, the risk indicator or HQ for aquatic species would be slightly reduced in each of the study areas compared to the Proposed Action. Although there is a slight reduction in Project risks from mercury and selenium, the combination of Renewable PFR Alternative with baseline conditions would represent the same risks and effects as discussed for the Proposed Action and the Natural Gas PFR Alternative.

3.12.4.5.1.2 Water Use

The effects of NGS water use on aquatic species under this alternative would be negligible, as described for the Proposed Action. Water use would result in very small change in the water levels in Lake Powell and the Colorado River below Glen Canyon Dam.

3.12.4.5.1.3 Effects of Implementation of Fish Conservation Measures

The effects of implementing the conservation measures for federally listed species in the San Juan River and Colorado River below Lake Powell on aquatic species would be the same as described for the Proposed Action and the Natural Gas PFR Alternative.

3.12.4.5.2 Proposed Kayenta Mine Complex

3.12.4.5.2.1 Operations, Reclamation, and Realignment of Navajo Route 41

The effects of mining disturbance and realignment of Route 41 on aquatic species would be minor, as described for the Proposed Action and Natural Gas PFR Alternative.

3.12.4.5.2.2 Emissions, Deposition, and Groundwater Pumping

The effects of the Renewable PFR Alternative from emissions and groundwater pumping on northern leopard would be the same as described for the Proposed Action and the Natural Gas PFR Alternative. There would be negligible effects on aquatic resources proposed KMC emissions and groundwater pumping in relation to the 8.1 million tpy (3-Unit Operation) and 5.5 million tpy (2-Unit Operation) coal production operations.

3.12.4.5.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

3.12.4.5.3.1 Operations and Maintenance

There would be no changes in the operations of the WTS, STS, or communications sites if the Natural Gas PFR Alternative were implemented. Impacts would be negligible aquatic species that occur in streams crossed by the WTS and STS, as described for the Proposed Action. BMPs and applicant-committed protection measures would be implemented to reduce impacts to a negligible level for aquatic species.

3.12.4.5.4 Project Impact Summary – All Project Components

In summary, the Renewable PFR Alternative would result in 3 to 11 percent power reduction compared to the Proposed Action, which would result in lower emissions and deposition of metals within the study area. As a result of lower deposition of metals, the risk indicator or HQ for aquatic species would be slightly reduced in each of the study areas compared to the Proposed Action. NGS emissions under this alternative by themselves represent a negligible risk on all species, as indicated by the very small HQ values. The effects of the Renewable PFR Alternative in combination with baseline conditions would be the same as described for the Proposed Action and the Natural Gas PFR Alternative. The reason for same effects is that the baseline fish tissue concentrations dictate the risks for aquatic species in all portions of the study area.

3.12.4.5.5 Cumulative Impacts

The combination of NGS and proposed KMC emissions under the Renewable PFR Alternative plus other cumulative deposition sources would result in the same total cumulative emission effects as described for the Proposed Action. The only difference is that the NGS contribution to total cumulative emissions would be slightly less compared to the Proposed Action, as indicated by slightly lower HQs. However, the project risk and contribution is so small that it does not change the overall effects to aquatic species.

3.12.4.6 Tribal Partial Federal Replacement Alternative

Under the Tribal PFR Alternative, between 100 MW and 250 MW of power generation from the NGS would be replaced by power supplied by a new photovoltaic generation facility on tribal land, displacing an equivalent amount of power from the federal share of NGS generation. The construction of a new photovoltaic generation site on tribal land would result in between 1,200 and 3,000 acres of new surface disturbance. The Tribal PFR facility would be analyzed in a separate National Environmental Policy Act process once a facility location is identified.

3.12.4.6.1 Navajo Generating Station

3.12.4.6.1.1 Emissions and Deposition

The Tribal PFR Alternative would result in the following percent reductions in power output for the 100-MW and 250-MW replacements in comparison to the Proposed Action: 2 and 5 percent for the 3-Unit Operation and 3 and 8 percent for the 2-Unit Operation. The reduction in power output would result in less coal burned and lower deposition of metals and other COPECs in the portions of the study area analyzed for NGS and associated facilities (i.e., NGS Near-field, Northeast Gap Region of the Colorado River, Southwest Gap Region of the Colorado River, and the San Juan River) when compared to the Proposed Action. As a result of lower deposition of metals, the risk indicator or HQ for aquatic species would be slightly reduced in each of the study areas compared to the Proposed Action. Although there is a slight reduction in Project risks from mercury and selenium, the combination of Tribal PFR

Alternative with baseline conditions would represent the same risks and effects as discussed for the Proposed Action and the Natural Gas PFR Alternative.

3.12.4.6.1.2 Water Use

The effects of NGS water use on aquatic species under this alternative would be negligible, as described for the Proposed Action. Water use would result in very small change in the water levels in Lake Powell and the Colorado River below Glen Canyon Dam.

There is a potential for surface water withdrawal from rivers and streams, or reservoirs for the purpose of providing water source for the project. There is a potential for effects on aquatic species if they occur in water sources used for withdrawals. The location of water sources and the water volumes have not been identified at this time. The potential occurrence of special status species would have to be considered, and withdrawal timing restrictions could be required. During preliminary feasibility studies, options to use groundwater, or municipal water should be considered to avoid direct effects on aquatic communities.

3.12.4.6.1.3 Effects of Implementation of Fish Conservation Measures

The effects of implementing the conservation measures for federally listed species in the San Juan River and Colorado River below Lake Powell on aquatic species would be the same as described for the Proposed Action and the Natural Gas PFR Alternative.

3.12.4.6.2 Proposed Kayenta Mine Complex

3.12.4.6.2.1 Operations, Reclamation, and Realignment of Navajo Route 41

The effects of mining disturbance and realignment of Route 41 on aquatic species would be minor, as described for the Proposed Action and Natural Gas PFR Alternative.

3.12.4.6.2.2 Emission, Deposition, and Groundwater Pumping

The effects of the Renewable PFR Alternative from emissions and groundwater pumping on aquatic species would be the same as described for the Proposed Action and the Natural Gas PFR Alternative. There would be negligible effects on aquatic resources proposed KMC emissions and groundwater pumping in relation to the 8.1 million tpy (3-Unit Operation) and 5.5 million tpy (2-Unit Operation) coal production operations.

3.12.4.6.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

3.12.4.6.3.1 Operations and Maintenance

There would be negligible impacts to the existing transmission systems and communication sites because no changes in the operations of the WTS, STS, or communications sites would occur due to the implementation of this alternative. Additional disturbance could occur to an unknown number of acres related to connecting a new photovoltaic generation site on tribal land to the existing transmission system and would be evaluated in a subsequent National Environmental Policy Act action. Impacts would be negligible to aquatic species that occur in streams crossed by the WTS and STS, as described for the Proposed Action. BMPs and applicant-committed protection measures would be implemented to reduce impacts to a negligible level for special status fish species.

3.12.4.6.4 Project Impact Summary – All Project Components

In summary, the Tribal PFR Alternative would result in 2 to 8 percent power reduction compared to the Proposed Action, which would result in lower emissions and deposition of metals within the study area.

As a result of lower deposition of metals, the risk indicator or HQ for aquatic species would be slightly reduced in each of the study areas compared to the Proposed Action. NGS emissions under this alternative by themselves represent a negligible risk on all species, as indicated by the very small HQ values. The effects of the Tribal PFR Alternative in combination with baseline conditions would be the same as described for the Proposed Action and the Natural Gas PFR Alternative. The reason for same effects is that the baseline conditions dictate the risks for aquatic species in all portions of the study area.

3.12.4.6.5 Cumulative Impacts

The combination of NGS and proposed KMC emissions under the Tribal PFR Alternative plus other cumulative deposition sources would result in the same total cumulative emission effects as described for the Proposed Action. The only difference is that the NGS contribution to total cumulative emissions would be slightly less compared to the Proposed Action, as indicated by slightly lower HQs. However, the project risk and contribution is so small that it does not change the overall effects to aquatic species.

3.12.4.7 No Action

3.12.4.7.1 Navajo Generating Station

Emissions under the No Action Alternative would be represented by the existing conditions plus the cumulative source impacts over the same time period (through 2074), but with the exclusion of current NGS emissions. The elimination of current NGS emissions would subtract a very small emission level from existing conditions. Basically, the effect of No Action emissions on aquatic species would be the same as described in the Near-field, Gap Regions, and San Juan River ERAs for baseline conditions plus other cumulative sources (Ramboll Environ 2016a,b,c). The No Action emission effects on aquatic species within each of the ERA study areas are summarized below.

- NGS Near-field and Northeast Gap Region – There would be no effects to aquatic community, benthic community and fish, as indicated by refined HQs being 1 or less than 1 for all COPECs.
- Southwest Gap Region – There would be potential adverse effects to fish species from mercury and selenium, as indicated by HQs exceeding 1. Hazard quotient results for the aquatic community indicated that there would be no effect. In addition, there would be no NGS water withdrawals and minor flow changes in the Colorado River below Lake Powell. In addition, no conservation measures as part of the NGS-KMC Project would be implemented for humpback chub and razorback sucker in the Colorado River below Glen Canyon Dam. As a result, there would be no effects on non-native fish species from control efforts.
- San Juan River – There would be no effects from mercury or selenium on the aquatic community and sediment community. However, there would be a potential effect from selenium exposure for some individual fish species such as longnose dace, red shiner, carp, and mosquitofish, as indicated by HQs equal to 1, although such effects are considered negligible as HQs are less than 1 for the fish community as whole. No effects were indicated for sport fish species under the No Action Alternative. In addition, no conservation measures as part of the NGS-KMC Project would be implemented for Colorado pikeminnow and razorback sucker in the San Juan River. As a result, there would be no effects on non-native fish species from control efforts or habitat enhancements.

Under the No Action Alternative, there would be a reduction in water usage and pumping of up to 40,000 acre-feet per year in Lake Powell due to the subtraction of NGS operations. This reduction would provide additional aquatic habitat in Lake Powell, which would be beneficial to aquatic species. The increase in habitat would be relatively small, but most evident in bays where shallower water is present.

3.12.4.7.2 Proposed Kayenta Mine Complex

The No Action Alternative would consist of existing activities within the proposed KMC with the exclusion of mining and emissions from the facilities and their associated activities, as well as proposed future mine dewatering. Under the No Action Alternative there would be about 165 ponds and internal draining impoundments at the proposed KMC after 2019; 115 of these would be removed by reclamation, leaving the 50 permanent impoundments at proposed KMC. However, existing ponds located within the reclamation area do not support fish, so the loss of habitat would not adversely affect aquatic resources. The No Action Alternative also consists of ongoing groundwater pumping of community wells, pumping from Peabody Western Coal Company wells to complete reclamation activities and to supply local resident and Manymules water needs, and the remnant effects of previous Peabody Western Coal Company pumping. Pumping under the No Action Alternative would result in flow reductions relative to 2020 flow rates of approximately 18 to 47 percent in Polacca, Chinle, and Begashibito washes and Laguna Creek, primarily caused by community pumping. No future mine dewatering from the proposed KMC facilities would occur under the No Action Alternative. The effect of emissions from the No Action Alternative would be the same as baseline conditions combined with other cumulative sources analyzed in the proposed KMC ERA. Emissions under the No Action Alternative would subtract the very small contribution from the proposed KMC facilities. Because the elimination of emission effects from the proposed KMC facilities would be very small, the resulting metal concentrations in waterbodies would be nearly the same as baseline conditions in combination with other cumulative sources characterized in the proposed KMC ERA (Ramboll Environ 2016d).

3.12.4.7.3 Transmission Systems and Communication Sites

The NGS transmission system is an established part of the western U.S. transmission grid and supports reliability and delivery of power throughout the region, well beyond the power generated by the NGS. Therefore, under the No Action Alternative it is likely that that one, several, or all of the land owners/managers of the transmission line rights-of-way and communication site leases would renew some portion of the facilities to keep the power grid performing as expected.

In the event it is determined that some or all of the transmission systems and communication site ROWs are not renewed, a lengthy study and permitting process would need to occur before any decommissioning is initiated due to the essential and integral nature of these facilities with the western electric grid. As noted in Section 2.3.3, up to 4,826 acres within and alongside the transmission system corridors could be temporarily disturbed if the entirety of the transmission systems and communication sites were decommissioned and removed.

Under the No Action Alternative, the WTS and STS would continue to be operated and maintained in terms of infrastructure maintenance, vegetation management, and the use and maintenance of access roads. The impacts of these activities on perennial streams that are near or crossed by the transmission line ROWs generally would be the same as discussed for the Proposed Action. The continuing ROW operator would be responsible for the operation and maintenance activities.

3.12.4.7.4 No Action Impact Summary – All Project Components

In summary, the No Action Alternative would result in emissions resulting from existing conditions plus the cumulative source impacts over the same time period (through 2074), but with the exclusion of current NGS emissions. The elimination of current NGS emissions would subtract a very small emission level from existing conditions. There would be no effects of No Action emissions on plant and invertebrate communities in any of the ERA analysis areas. However, there would be a low effect of mercury and selenium in the Southwest Gap Region and selenium in the San Juan River on some non-sport fish species. Because the elimination of emission effects from the proposed KMC facilities would be very small, the resulting metal concentrations in waterbodies would be nearly the same as baseline conditions in combination with other cumulative sources characterized in the proposed KMC ERA. Pumping under the No Action Alternative would result in flow reductions of approximately 18 to 47 percent relative to 2020 rates in Polacca, Chinle, and Begashibito washes and Laguna Creek, which would reduce aquatic habitat and invertebrate and plant abundance when water is present. These reductions are primarily caused by local community pumping. No future mine dewatering from the proposed KMC facilities would occur under the No Action Alternative. The impacts of No Action on perennial streams and aquatic species that are near or crossed by the transmission line ROWs generally would be the same as discussed for the Proposed Action.

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Section 3.13

Special Status Aquatic Resources

Acronyms and Abbreviations

1969 Lease	Navajo Project Indenture of Lease
AGFD	Arizona Game and Fish Department
BART	Best Available Retrofit Technology
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BM&LP Railroad	Black Mesa & Lake Powell Railroad
BO	Biological Opinion
CAP	Central Arizona Project
CBR	critical body residue
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CO_2	carbon dioxide
COPEC	chemical of potential ecological concern
Co-tenants	Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
Development Fund	Lower Colorado River Basin Development Fund
EIS	Environmental Impact Statement
ERA	Ecological Risk Assessment
ESA	Endangered Species Act of 1973
HHRA	Human Health Risk Assessment
km	kilometer
KMC	Kayenta Mine Complex
kV	kilovolt
kW	kilowatt
mg/kg	millogram/kilogram
MW	megawatt
N-Aquifer	Navajo Aquifer
NAC	Nevada Administrative Code
NEPA	National Environmental Policy Act of 1969, as amended
NGS	Navajo Generating Station
NGS Participants	U.S. (Reclamation), Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
NHPA	National Historic Preservation Act
NNEPA	Navajo Nation Environmental Protection Agency
NO_2	nitrogen dioxide
NO_X	nitrogen oxide
NPS	National Park Service
OSMRE	Office of Surface Mining Reclamation and Enforcement
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less

$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 microns or less
PFR	Partial Federal Replacement
PIT	Passive Integrated Transponder
PWCC	Peabody Western Coal Company
Reclamation	U.S. Bureau of Reclamation
ROW	Right-of-way
SO_2	sulfur dioxide
SRP	Salt River Project Agricultural Improvement and Power District
STS	Southern Transmission System
U.S.	United States
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
WTS	Western Transmission System

Contents

3.13 Special Status Aquatic Species 3.13-1
3.13.1 Regulatory Framework 3.13-1
3.13.2 Study Areas 3.13-3
3.13.2.1 Proposed Action and Action Alternatives 3.13-3
3.13.2.2 Cumulative Effects 3.13-3
3.13.2.3 Ecological Risk Assessment - Role in Assessing Baseline Risk and Environmental Consequences 3.13-6
3.13.3 Affected Environment 3.13-7
3.13.3.1 Navajo Generating Station 3.13-7
3.13.3.2 Proposed Kayenta Mine Complex 3.13-28
3.13.3.3 Transmission Systems and Communication Sites 3.13-29
3.13.4 Environmental Consequences 3.13-37
3.13.4.1 Issues 3.13-37
3.13.4.2 Assumptions and Impact Methodology 3.13-38
3.13.4.3 Proposed Action 3.13-41
3.13.4.4 Natural Gas Partial Federal Replacement Alternative 3.13-78
3.13.4.5 Renewable Partial Federal Replacement Alternative 3.13-84
3.13.4.6 Tribal Partial Federal Replacement Alternative 3.13-85
3.13.4.7 No Action 3.13-86
3.13.5 References 3.13-88

List of Appendices

Appendix 3.13-A - Injury Effects Methodology

Appendix 3.13-B - ERA Results for the Proposed Action in Combination with Baseline and Other Cumulative Emissions

List of Tables

Table 3.13-1 Relevant Statutes, Regulations, and Policies for Aquatic Species 3.13-1

Table 3.13-2 Federally Listed Fish Species Occurrence in the Lake Powell, Colorado River Gap Regions, and Lower San Juan River Study Areas 3.13-8

Table 3.13-3 Northeast Gap Risk Results for Bonytail Using Surrogate Species Data (Existing Conditions) 3.13-11

Table 3.13-4 Northeast Gap Risk Results for Colorado Pikeminnow Using Surrogate Species Data (Existing Conditions) 3.13-17

Table 3.13-5 San Juan River Risk Results for Colorado Pikeminnow Using Surrogate Species Data (Existing Conditions) 3.13-17

Table 3.13-6 San Juan River Risk Results for Colorado Pikeminnow Using Colorado Pikeminnow Tissue Data (Existing Conditions) 3.13-18

Table 3.13-7 Gap Region Risk Results for Humpback Chub Using Surrogate Species and Baseline Fish Tissue Data (Existing Conditions) 3.13-22

Table 3.13-8 Northeast Gap Risk Results for Razorback Sucker Using Surrogate Species Data (Existing Conditions) 3.13-25

Table 3.13-9 Southwest Gap Region Risk Results for Razorback Sucker Using Surrogate Species and Baseline Fish Tissue Data (Existing Conditions) 3.13-26

Table 3.13-10 San Juan River Risk Results for Razorback Sucker Using Surrogate Species and Baseline Fish Tissue Data (Existing Conditions) 3.13-26

Table 3.13-11 San Juan River Risk Results Using Razorback Sucker Tissue and Baseline Fish Tissue Data (Existing Conditions) 3.13-27

Table 3.13-12 Other Special Status Aquatic Species in the Lake Powell, Colorado River Gap Regions, and San Juan River Analysis Areas 3.13-28

Table 3.13-13 Special Status Aquatic Species Occurring in Streams Crossed by the Transmission Systems 3.13-29

Table 3.13-14 Mercury and Selenium Tissue Concentrations for Bonytail Surrogate (Rainbow Trout) in the Northeast Gap Region 3.13-42

Table 3.13-15 Mercury and Selenium Tissue Concentrations for Colorado Pikeminnow Surrogate (Largemouth Bass) in the Northeast Gap Region 3.13-44

Table 3.13-16 Arsenic, Mercury, and Selenium Tissue Concentrations for Colorado Pikeminnow Surrogate (Striped Bass) in the San Juan River 3.13-45

Table 3.13-17 Arsenic, Mercury, and Selenium Tissue Concentrations for Colorado Pikeminnow Tissue in the San Juan River 3.13-45

Table 3.13-18 Mercury Injury Effects to Colorado Pikeminnow in the San Juan River, 2020 to 2074 .... 3.13-46

Table 3.13-19 Mercury and Selenium Tissue Concentrations for Humpback Chub in the Southwest Gap Region 3.13-51

Table 3.13-20 Mercury and Selenium Injury Effects to Humpback Chub in the Southwest Gap Region, 2020 to 2074, 3-Unit Operation 3.13-52

Table 3.13-21 Mercury and Selenium Tissue Concentrations for Razorback Sucker in the Southwest Gap Region 3.13-55

Table 3.13-22 Mercury and Selenium Injury Effects to Razorback Sucker in the Southwest Gap Region, 2020 to 2074, 3-Unit Operation 3.13-56

Table 3.13-23 Arsenic, Mercury, and Selenium Tissue Concentrations for Razorback Sucker Surrogates in the San Juan River 3.13-57

Table 3.13-24 Arsenic, Mercury, and Selenium Tissue Concentrations for Razorback Sucker in the San Juan River 3.13-57

Table 3.13-25 Mercury and Selenium Injury Effects to Razorback Sucker in the San Juan River, 2020 to 2074 .... 3.13-58

Table 3.13-26 Mercury and Selenium Injury Effects to Colorado Pikeminnow in the San Juan River, 2020 to 2074 .... 3.13-70

Table 3.13-27 Mercury and Selenium Injury Effects to Humpback Chub in the Southwest Gap Region, 2020 to 2074 .... 3.13-73

Table 3.13-28 Mercury and Selenium Injury Effects to Razorback Sucker in the Southwest Gap Region, 2020 to 2074 .... 3.13-76

Table 3.13-29 Mercury and Selenium Injury Effects to Razorback Sucker in the San Juan River, 2020 to 2074 .... 3.13-76

Table 3.13-30 Comparison of Mercury HQs for the Proposed Action and Natural Gas PFR Alternative 3.13-79

List of Figures

Figure 3.13-1 Federally Listed Fish Species Critical Habitat for NGS and Proposed KMC 3.13-4

Figure 3.13-2 Federally Listed Fish Species Critical Habitat for Transmission Systems 3.13-5

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3.13 Special Status Aquatic Species

3.13.1 Regulatory Framework

Laws, regulations, and policies that directly influence management decisions for the special status aquatic species within the project study area primarily are implemented by the U.S. Fish and Wildlife Service (USFWS), Navajo Nation, Hopi Tribe, Bureau of Land Management (BLM), U.S. Forest Service, and state fish and wildlife agencies (Arizona, Nevada, New Mexico, and Utah). A summary of prominent laws, regulations, directives, and agreements relevant to the Proposed Action are listed in **Table 3.13-1**.

Table 3.13-1 Relevant Statutes, Regulations, and Policies for Aquatic Species

Statutes, Regulations, or Policies	Summary
Arizona Game and Fish Title 17, Game and Fish, Wildlife Habitat Protection, Aquatic Invasive Species	The State of Arizona's Title 17 – Game and Fish Revised Statutes establish policies and programs for the management, preservation, and harvest of wildlife including aquatic species. Policies directed at managing and conserving aquatic species include invasive species programs and lists, funding/fiscal provisions, rules regarding taking and handling wildlife, and other prohibitions.
Utah Code 23-14-1and Rule R657-48	Section 23-14-1 of the Utah State Code directs the Utah Division of Wildlife Resources to protect, propagate, manage, conserve, and distribute protected wildlife throughout the state. This statute also authorizes Utah Division of Wildlife Resources to identify and delineate crucial seasonal wildlife habitats. R657-48 establishes wildlife species of concern and habitat designation; defines the Utah Sensitive Species List; defines the procedure for the designation of wildlife species of concern as part of the a process to preclude listing under the Endangered Species Act (ESA); and defines the procedure for review, identification and analysis of wildlife habitat designation and management recommendations relating to significant land use development projects.
New Mexico Title 19 – Natural Resources and Wildlife, Chapter 33, Endangered and Protected Species	Rule 19 New Mexico Administrative Code 33.2 provides protection for species classified as threatened and endangered by the New Mexico Game Commission through rules involving the removal, capture or destruction of their habitat. Rule 19 New Mexico Administrative Code 33.6 provides a list of New Mexico threatened and endangered species.
Nevada Administrative Code (NAC) NAC 503.072, NAC 503.074, and NAC 503.075.	NAC classifies protected, endangered, and threatened fish species in Nevada. NAC 503.072 classifies injurious aquatic species. NAC 503.074 classifies aquatic invasive species. NAC 503.075 classifies amphibians as game, protected, threatened, sensitive, endangered, and unprotected.
Surface Mining Control and Reclamation Act of 1977	The Surface Mining Control and Reclamation Act of 1977 establishes a program for the regulation of surface mining activities and the reclamation of coal-mined lands, under the administration of the Office of Surface Mining, Reclamation and Enforcement. The law establishes minimum requirements for all coal surface mining on Federal and State lands, including exploration activities and the surface effects of underground mining. Mine operators are required to minimize disturbance and adverse impacts to biological resources and achieve enhancement of these resources where practicable.
Endangered Species Act of 1973	The ESA provides broad protection for species of fish, wildlife, and plants listed as threatened or endangered by the USFWS. Provisions are made for listing species, as well as for recovery plans, and the designation of critical habitat for listed species. All federal agencies in consultation with the USFWS also must use their authorities in furtherance of the purposes of the ESA by carrying out programs for the conservation of listed species. All federal agencies, in consultation with, and assistance of, the USFWS must ensure any action authorized, funded, or carried out by a federal agency is not likely to jeopardize the continued existence of an endangered,

Table 3.13-1 Relevant Statutes, Regulations, and Policies for Aquatic Species

Statutes, Regulations, or Policies	Summary
	threatened, or proposed listed species, or result in destruction or adverse modification of critical habitat of a species. Agencies are required to use the best scientific and commercial data available to fulfill this objective.
Navajo Nation Endangered Species compliance: Navajo Nation Biological Resource Land Use Clearance Policies and Procedures, Code RCS-44-08 and RCS-41-08 [1]	RCS-44-08: The purpose of the Navajo Nation Biological Resource Land Use Clearance Policies and Procedures is to assist the Navajo Nation government and chapters to ensure compliance with federal and Navajo laws which protect wildlife resources, including plants, and their habitat resulting in an expedited land use clearance process. The Navajo Nation Biological Resource Land Use Clearance Policies and Procedures assists in directing development to areas where impacts to wildlife and/or their habitat will be less significant. Development includes but is not limited to human activities that result in permanent structures, temporary, long-term, or repetitive disturbance to wildlife or habitat as defined by Navajo Nation Code 17 Navajo Nation Code 500 et. section. RCS-41-08: establishes the Navajo Endangered Species List, last updated on September 10, 2008.
BLM Sensitive Species Management (BLM Manual 6840)	BLM Manual 6840 contains BLM's special status species management policy and guidance for the conservation of special status species and their habitats. Under this policy, special status species include animal and plant species listed as threatened or endangered, proposed for listing, and candidates for listing under the provisions of the ESA; those listed as sensitive species by a state; and those listed by the BLM State Director as sensitive. The objective of this policy is to ensure actions requiring authorization or approval by the BLM are consistent with the conservation needs of special status species and do not contribute to the need to list any special status species, under provisions of the ESA.
Sensitive Species Lists for Arizona, Utah, New Mexico, and Nevada	AZ-2011-005 identifies BLM Sensitive plant and animal species on BLM-administered lands in Arizona. By Administrative Rule R657-48, the Utah Division of Wildlife Resource maintains the *Utah Sensitive Species List* which contains wildlife species that are federally listed, candidates for federal listing, or for which a conservation agreement is in place. Additional species are added to the list as "wildlife species of concern" where there is credible scientific evidence to substantiate a threat to continued viability of populations of such species. Nevada Division of Wildlife's listed species are "protected" under the authority of NAC 501.100 - 503.104 (wildlife). New Mexico Department of Game and Fish listed species are protected under Rule 19 NMAC 33.6.
Forest Service Sensitive Species Compliance	Section 2670 of the U.S. Forest Service Manual directs each Regional Forester to designate sensitive species on lands managed by the U.S. Forest Service. A sensitive species is defined as: a "plant or animal species identified by a Regional Forester for which population viability is a concern, as evidenced by a significant current or predicted downward trend in population numbers or density, or significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution." The National Forest Management Act requires the U.S. Forest Service to identify certain vertebrate and/or invertebrate species as Management Indicator Species. Management Indicator Species are used to establish forest plan objectives for important wildlife and fish habitats, and to estimate the effects of forest plans and projects on fish and wildlife populations.

[1] Applies to the Proposed KMC only. Under the 1969 Lease, the Navajo Nation agreed not to regulate the construction, maintenance or operation of NGS facilities, including the BM&LP Railroad, as well as the WTS and STS on Navajo Nation land.

3.13.2 Study Areas

3.13.2.1 Proposed Action and Action Alternatives

The study area for special status aquatic species was determined by relating species occurrences to the three project components, Navajo Generating Station (NGS), proposed Kayenta Mine Complex (KMC), and the Western and Southern transmission line systems (WTS and STS) (**Figures 3.13-1** and **3.13-2**). The NGS portion of the study area was further divided geographically into three deposition impact areas with each focused on special status aquatic species occurrence and habitat parameters within the ecological risk assessments (ERAs) conducted for this Environmental Impact Statement (EIS) (Ramboll Environ 2016a,b,c). The areas were delineated based on an iterative process during the development of the risk assessments and in coordination with the USFWS and cooperating agencies. Coordination for the emission study areas was completed as part of the process for defining sampling locations, data review, and methodologies for the ERAs (Ramboll Environ 2016a,b,c,d).

As discussed in Section 3.0.3, Ecological and Human Health Risk Assessments, three ERAs were conducted to analyze the effects of NGS emissions and the resulting deposition of chemicals on ecological receptors in Lake Powell (NGS Near-field ERA), the Colorado River (Northeast and Southwest Gap Regions), and the San Juan River (San Juan River ERA). The NGS Near-field study area consists of a 20-kilometer (km) radius from the NGS Facility that overlaps with a portion of Lake Powell. The Northeast Gap Region extends from Lake Powell upstream to the confluence with the Green River. The Southwest Gap Region extends from the Glen Canyon Dam downstream to the confluence with the Little Colorado River. The San Juan River study area extends from the San Juan River arm in Lake Powell upstream in the San Juan River to the Farmington area.

Due to lack of perennial aquatic habitat, no special status aquatic species occur in the study area for the Black Mesa & Lake Powell (BM&LP) Railroad.

The proposed KMC portion of the project study area included the intermittent drainages within the proposed KMC boundary and Navajo Aquifer (N-Aquifer) groundwater study area (**Figure 3.7-3** in Water Resources). An ERA also was conducted for the proposed KMC, with the study area consisting of the proposed KMC boundary plus areas related to the occurrence of federally listed species, Navajo sedge and Mexican spotted owl (Ramboll Environ 2016d). These species are discussed in Sections 3.9 and 3.11, respectively.

The portion of the project study area involving transmission lines consisted of perennial streams that are crossed by the WTS and STS rights-of-way (ROWs), which potentially support special status aquatic species and their habitat (**Figure 3.13-2**). The study area for the transmission systems included the ROW and an additional 500-foot width on either side of the ROW to cover access roads. The streams included the Verde and Aqua Fria rivers for the STS ROW and the Colorado, Paria, Virgin, and Muddy rivers and Meadow Valley and Gypsum washes for the WTS ROW. No special status aquatic species occur within the transmission line communication sites.

3.13.2.2 Cumulative Effects

The cumulative effects study area for the NGS project component is expanded to include the effects of activities in the Upper Colorado River Basin and the upstream portion of the San Juan River to the Navajo Dam. The portion of the Colorado River below Glen Canyon Dam is extended downstream to the inflow to Lake Mead.

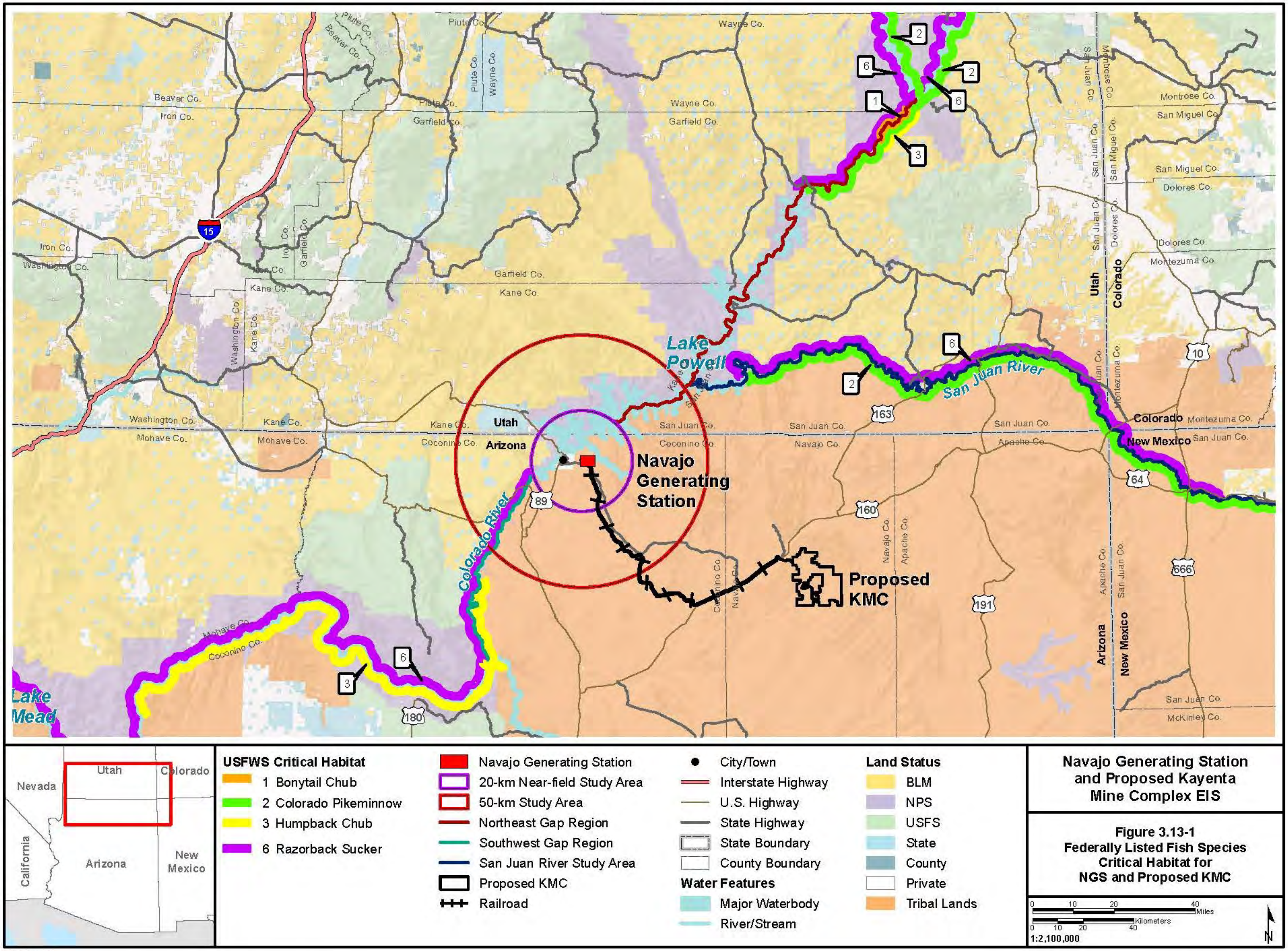
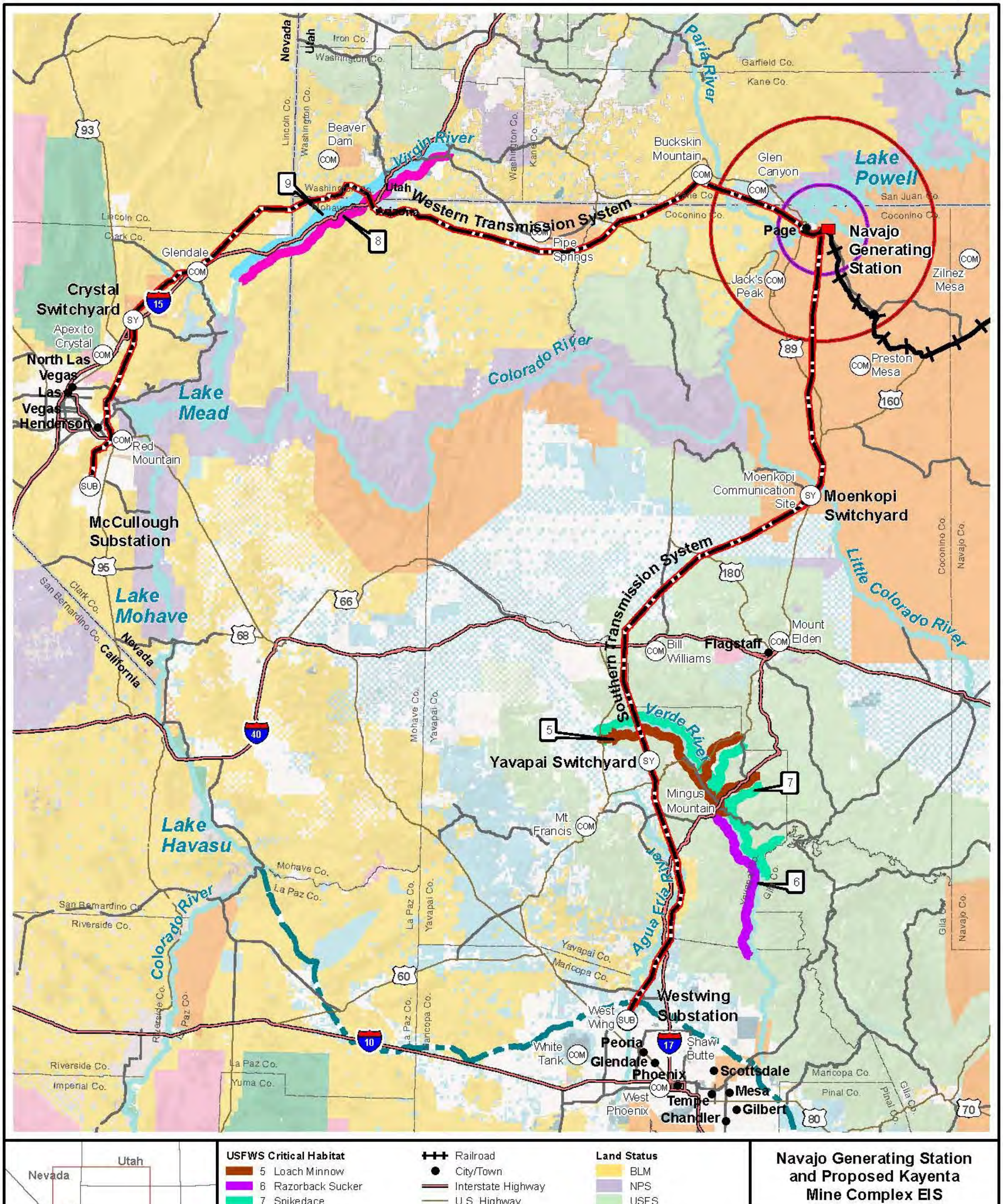


Figure 3.13-1
Federally Listed Fish Species Critical Habitat for NGS and Proposed KMC

7/20/2016



Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 3.13-2 Federally Listed Fish Species Critical Habitat for Transmission Systems

7/20/2016

3.13.2.3 Ecological Risk Assessment - Role in Assessing Baseline Risk and Environmental Consequences

The potential for risk to special status aquatic species was evaluated under current conditions (referred to as baseline or baseline conditions), and potential future conditions that considers the deposition of chemicals from NGS emissions. The evaluation of special status aquatic species initially included a screening of areas potentially affected by NGS and KMC emissions. The analysis focused those study areas where such species are known or expected to occur. Specific evaluation of risk to special status aquatic species was conducted only for the NGS Near-field, Gap Regions, and San Juan River study areas and KMC area (Ramboll Environ 2016a,b,c,d).The ERAs were intended to (1) investigate whether the combination of site-specific exposure scenarios and chemicals of potential ecological concern (COPECs) may pose current or potential future risks to ecological receptors, and (2) provide information necessary to support the EIS process. ERA involves four key components: problem formulation, analysis (exposure/toxicity assessment), risk characterization, and uncertainty analysis. Section 3.0.3 provides an overview of the ERA process and key risk assessment concepts. **Appendix 3RA** provides further detail of the process and a summary of the ERAs conducted for the project. The reader is directed to each of the ERAs (Ramboll Environ 2016a,b,c) for specific detail and rationale for the data evaluated and analyses conducted regarding special status aquatic species.

The outcome of the problem formulations (conceptual site model) for the ERAs identified the known or expected occurrence of four federally listed fish species (bonytail, Colorado pikeminnow, humpback chub, and razorback sucker) within one or more of the three NGS study areas (Ramboll Environ 2016a,b,c). One special status species, northern leopard frog, was analyzed for the KMC area (Ramboll Environ 2016d). Ecological receptors are described in the context of assessment endpoints (explicit expression of the environmental value to be protected), and measures of effect (ecological characteristic(s) that quantify the assessment endpoint) as defined by the U.S. Environmental Protection Agency (USEPA) guidance (USEPA 1997). The following assessment endpoint and measures of effect were defined for special status fish in each of defined study areas for the project (NGS Near-field, Gap Regions, and San Juan River study areas):

- Special Status Species Fish
  - Assessment Endpoint: protection and maintenance of individual fish within the defined study area.
  - Measures of Effect: comparison of measured (based on available literature) and/or modeled fish tissue concentrations to no effect tissue-based critical body residue (CBR) thresholds identified in available literature.

The Analysis/Exposure Assessment (USEPA 1998, 1997) phase of the NGS ERAs (Ramboll Environ 2016a,b,c,) presents the assumptions and parameters used to develop estimates of exposure, which specifically include determination of environmental concentrations to which a given receptor may be exposed (exposure point concentrations). For special status fish species, exposure is based on the integration of all exposure routes including exposure via respiration (gills), food intake and direct contact with aquatic media. To the extent possible exposure (tissue) data obtained for a given special status fish species was used. However, these data are generally limited and so in the absence of such data, data for surrogate fish species were used. Surrogates were selected during development of the ERAs and were based on similarity of life history factors, most importantly habitat preference, diet, and feeding strategy. The specific surrogates are defined subsequently in the context of each specific study area in Section 3.13.4, as the use of species as surrogates was constrained by the availability of data and so may differ between study areas.

The Analysis/Effects Assessment (USEPA 1998, 1997) phase of the ERAs compiles available toxicity information and correlates receptor exposure to the potential for an undesirable effect to organism health, where a medium-specific screening benchmark or CBR is identified and subsequently used to characterize the potential for risk. The quantitative metric used to characterize risk, conducted within the context of the Risk Characterization phase, is the Hazard Quotient (HQ). Information regarding how HQs are calculated, and interpretation of the HQ was summarized in Section 3.0.3 and is detailed in **Appendix 3RA** and the individual ERA reports (Ramboll Environ 2016a,b,c,d).

The HQ used for evaluation of special status fish was based on comparison of literature-derived fish tissue concentrations (whole body concentrations) from studies conducted in study area waterbodies to established CBRs protective of fish health. Baseline mercury-tissue based HQs were estimated for special status fish using available fish tissue data from the literature and the 0.2 milligram/kilogram (mg/kg) wet weight (whole body) no effect threshold (Beckvar et al. 2005). This study identified a whole body threshold effect level to be protective of juvenile and adult fish, based primarily on sublethal effects such as growth, reproduction, development, and behavior. Below this threshold, adverse effects in fish are unlikely. Dillon et al. (2010) reported mercury dose-response curves for early life stage and juvenile or adult fish, based on published tissue-residue toxicity studies, including those considered by Beckvar et al. (2005). Dillon et al. (2010) identified 0.77 mg/kg wet weight as the lowest observable effect level.

As described in Section 3.0.3, HQs were calculated for each NGS operational scenario to account for current and potential future conditions: baseline, 3-Unit Operation, 2-Unit Operation, 2-Unit Operation with Partial Federal Replacement (PFR), and other cumulative sources. Given the number of scenarios evaluated, all COPECs and receptors were carried forward throughout the ERA process, such that a “total cumulative sources” risk estimate could be determined that incorporates baseline, a given NGS production option (deposition-related contributions) and other cumulative sources (e.g., baseline + 3-Unit Operation + OCS) (Ramboll Environ 2016a,b,c). For each of these scenarios, HQs were developed for the maximum, refined, and average exposure scenarios for all receptors. For evaluation of special status species, both maximum and refined HQs were used. While refined HQs are considered to be a realistic estimate of exposure, the ERA convention is to include maximum concentrations as a highly conservative measure when evaluating potential risk to individuals. The refined HQ results are based on comparison of the exposure point concentration represented by the 95 percent upper confidence limit on the arithmetic average wherever it could be calculated, as described in Section 3.0.3. Use of this value generally represents a more realistic estimate of exposure versus use of a maximum concentration and resulting maximum HQ, as ecological receptors are unlikely to be exposed to the highest level of all COPECs at all times (an unrealistic and highly conservative assumption). Although both maximum and refined HQs are provided, the environmental consequences section for each species focuses on the refined HQs as an indicator of risk to special status species. Section 3.0.3 provides an overview of the interpretation of HQs.

3.13.3 Affected Environment

3.13.3.1 Navajo Generating Station

3.13.3.1.1 Habitat

Habitats for special status aquatic species for the NGS portion of the project study area consist of Lake Powell, the Colorado River above Lake Powell to the Green River confluence, the Colorado River below Glen Canyon Dan downstream to the Little Colorado River confluence, and San Juan River. Descriptions of Lake Powell and the riverine habitats associated with the Northeast and Southwest Gap Regions of the Colorado River and the San Juan River are provided in Section 3.12.1.1, Aquatic Resources/ Analysis Areas.

3.13.3.1.2 Federally Listed, Candidate, and Proposed Aquatic Species

Five federally listed aquatic species occur in portions of the NGS Near-field study area (i.e., the 20-km deposition area), Gap Regions, and San Juan River from Lake Powell to the Farmington area. Federally listed species include four fish species (bonytail, Colorado pikeminnow, humpback chub, and razorback sucker) and one snail (Kanab ambersnail). All of these species also are considered Arizona Species of Greatest Conservation Need. The occurrence of these species and their critical habitat is listed in **Table 3.13-2**. Critical habitat for the listed fish species is shown in **Figure 3.13-1**. The following information provides a summary of their occurrence, critical habitat, habitat preferences, life history, listing status, recovery efforts, and factors affecting their environment and critical habitat.

Table 3.13-2 Federally Listed Fish Species Occurrence in the Lake Powell, Colorado River Gap Regions, and Lower San Juan River Study Areas

Species	Federal Status	Lake Powell Near the Colorado River Inflow	Lake Powell Near San Juan River Inflow	Colorado River Above Lake Powell Northeast Gap Region	Colorado River Below Lake Powell Southwest Gap Region	San Juan River
Bonytail	Endangered	X[1]		X (CH)[2]		
Colorado pikeminnow	Endangered	X[1]	X	X (CH)		X (CH)
Humpback chub	Endangered			X	X (CH)	
Razorback sucker	Endangered	X	X	X (CH)	X (CH)	X (CH)
Kanab ambersnail	Endangered				X	

[1] Rare occurrence in Lake Powell.

[2] CH = Designated Critical Habitat.

3.13.3.1.2.1 Bonytail

Species Occurrence

Bonytail were once widespread in the large rivers of the Colorado River Basin (USFWS 2002a). Currently, no self-sustaining populations of bonytail exist in the wild and very few individuals have been captured throughout the Upper and Lower River Colorado basins (USFWS 2002a). The total adult population size is unknown, but it is considered to be small due to the limited numbers that have been collected. Significant numbers of bonytail were last captured in the Upper Colorado River Basin (lower Yampa and Green rivers) in the 1960s and early 1970s shortly after the closure of Flaming Gorge Dam (NatureServe 2013a). Since 1977, only 11 bonytail have been captured (USFWS 2002a). Captures of wild bonytail have occurred in three lakes in the lower basin (Powell, Mohave, and Havasu), but the numbers were less than 50 total fish (USFWS 2002a). Today bonytail are considered functionally extirpated from the lower Colorado River. Bonytail stocking has occurred in the upper and lower basins, but self-sustaining populations have not been established (USFWS 2012a). In the Upper Colorado River Basin, a recovery goal of establishing a self-sustaining population of 4,400 adults over a 5-year period in the Green River subbasin has been set, but the criterion has not been met (USFWS 2012a). One of the recovery goals in the Lower Colorado River Basin is to establish two self-sustaining populations where naturally produced fish exceed the mean annual adult mortality. Abundance information for the portions of the action area analyzed for bonytail is provided below.

Lake Powell

The occurrence of bonytail in Lake Powell is rare. Four fish were captured in Lake Powell at the Colorado River inflow during 2014 (Francis 2014). The fish were stocked in the Colorado and San Rafael rivers and traveled approximately 143 to 277 miles, respectively, to the inflow area. Bonytail have not been detected in the 20-km Near-field ERA analysis area including the lower portion of Lake Powell near the NGS pump station and intakes. The Colorado River inflow area to Lake Powell is considered part of the Northeast Gap area, since the Near-field ERA analysis area does not extend to the arms of the lake.

Northeast Gap Region

Bonytail occurs in the Cataract Canyon portion of the Colorado River, which also has been designated as critical habitat for the species. Population estimates in 2003 indicated a population size of 264 individuals in Cataract Canyon (Badame 2008). All bonytail were stocked fish that originated from the Green River.

Life History and Habitat Association

The general types of habitat used by bonytail consist of mainstem riverine areas and impoundments in the Colorado River system. Deep pools and eddies with slow to fast currents are characteristic of the riverine habitat (Kaeding et al. 1986). Based on five specimens captured in the Upper Colorado Basin, four were captured in deep, swift, rocky canyon areas (i.e., Yampa Canyon, Black Rocks, Cataract Canyon, and Coal Creek Rapid) (USFWS 2002a). The fifth specimen was collected in Lake Powell. All fish collected in the Lower Colorado River Basin since 1974 were in reservoir habitats. Critical habitat includes river channels and flooded, ponded, or inundated riverine areas, especially where competition from non-native fishes is absent or reduced (USFWS 1994).

As discussed in USFWS (1994), Principal Constituent Elements for the critical habitat of the four Colorado River federally endangered fish species include the following components:

1. Water – This component includes a quantity of water of sufficient quality (i.e., temperature, dissolved oxygen, nutrients, turbidity, lack of contaminants, etc.) that is delivered to a specific location in accordance with the hydrologic regime that is required for a particular life stage for each species.
2. Physical Habitat – This component includes areas of the Colorado River system that are inhabited or potentially habitable by fish for use in spawning, nursery, feeding, and rearing, or corridors between these areas. In addition to river channels , these areas also include bottom lands, side channels, oxbows, backwaters, and other areas in the 100-year floodplain., which when inundated provide spawning, nursery, feeding, and rearing habitats, or access to these habitats.
3. Biological Environment – Food, predation, and competition elements of the biological environment are considered important components. Food supply is a function of nutrient supply, productivity, and availability to each life stage of the species. Predation and competition, although normal components of the biological environment, can be out of balance due to introduced non-native fish species.

It is assumed that spawning occurs in June or July, based on fish being observed in reproductive condition at 18ºC in the Green River (USFWS 2002a). Spawning has been observed in reservoirs over rocky shoals and shoreline areas (USFWS 2002a). A recent documentation of wild bonytail spawning in 2015 was reported for a wetland (Stewart Lake) in Utah, based on the collection of young-of-the-year (Breen 2016). Flooded bottomland habitats are considered important growth and conditioning areas, particularly as nursery areas for young. This species is a broadcast spawner that scatters adhesive eggs over gravel substrate at depths up to 30 feet. Newly hatched larvae and young bonytail develop in flooded bottomlands.

Listing and Conservation Status

Bonytail was listed as endangered under the ESA on April 23, 1980 (45 Federal Register 27710). On March 21, 1994, the USFWS designated seven reaches of the Colorado River system as critical habitat for bonytail (USFWS 1994). Critical habitat is designated in portions of the Colorado, Green, and Yampa rivers in the Upper Colorado River Basin and the Colorado River in the Lower Colorado River Basin. In total, 312 miles of critical habitat for bonytail exists in these seven reaches. One of these reaches overlaps with portions of the action area that were analyzed for this species, which includes 12.8 miles of bonytail critical habitat in the Northeast Gap Region.

A recovery plan for bonytail was completed in 1984, revised in 1990, and then updated in 2002 (USFWS 2002a). The upper basin subunit is composed of the Green River and Upper Colorado River, and the lower basin unit includes the mainstem and tributaries of the Colorado River from Lake Mead downstream to the International Boundary with Mexico. The most recent recovery review in 2012 indicated that bonytail has not yet achieved demographic recovery goals that are indicative of a healthy, viable, and sustainable population level (USFWS 2012a). The review also concluded that the most meaningful threats to bonytail include habitat availability, protection from predation, and degraded water quality. Bonytail will be considered eligible for downlisting from endangered to threatened and for removal from ESA protection when all of the following conditions are met:

- Self-sustaining fish populations reach the required numbers in the areas of the Green and Upper Colorado river subbasins and the Lower Colorado River Basin, and a genetic refuge is established in the Lower Basin;
- Essential habitats, including required instream flows, are legally protected; and
- Other identifiable threats that could significantly affect the population are removed.

Factors Affecting Species

Habitat occupied by bonytail is within Cataract Canyon, which is located in the upper portion of the Northeast Gap Region. Cataract Canyon begins 4 miles downstream of the confluence with the Green River and extends approximately 37 miles (Badame 2008). The upper 10 miles of the canyon is within Canyonlands National Park and the lower 27 miles is within the Grand Canyon National Recreation Area. Habitat in the upper section of the canyon mainly consists of large eddy/pool complexes interspersed between large rapids. Some of the larger pools are 75 feet deep. The lower 32 miles of Cataract Canyon are inundated by Lake Powell at full-pool elevation (Badame 2008).

Limiting factors for bonytail in the Northeast Gap Region include streamflow reductions due to water diversions; habitat fragmentation; competition with and predation by non-native fish species; and water quality changes due to pesticides and pollutants (USFWS 2002a). In the Upper Colorado River Basin, the Green and Colorado Rivers have been depleted approximately 20 percent (at Green River) and 32 percent (at Cisco), respectively (Holden 1999 as cited in USFWS 2015a). Increasing air temperatures and decreasing flows in the Colorado River have been documented, based on information provided in Hoerling et al. (2013). Temperature and water flow and/or volume are key components of habitat quality for aquatic species. The construction of 14 major dams in the Colorado River has fragmented habitat and blocked migration corridors for bonytail and other federally endangered fish species (USFWS 2002a). A large number of non-native fishes are found in the current occupied habitat of bonytail. Many of these non-native fish are considered predators, competitors, and vectors of disease and parasites. Previous accounts of hybridization of bonytail also have been reported in Cataract Canyon (USFWS 2002a). A discussion of the baseline water quality conditions with a focus on metals in the Gap Region ERA (Ramboll Environ 2016c) is provided in Water Resources Section 3.7.3.2, NGS and Associated Facilities.

<u>*Ecological Risk*</u>

Bonytail were evaluated in the Gap Region ERA by comparison of measured fish tissues concentrations, where available, to CBRs protective of fish health. Modeled fish tissue concentrations also were considered in the absence of measured values. The CBRs used for evaluation of special status species included: mercury 0.2 mg/kg wet weight (Beckvar et al. 2005), selenium 2 mg/kg wet weight (USEPA 2016), and arsenic 5.5 mg/kg wet weight (Jarvinen and Ankley 1999), as cited in the ERAs. In the Northeast Gap, tissue data were available for mercury only. Tissue data for the other metals was modeled from surface water data.

Based on the Gap Region ERA results regarding ecological risk, there is negligible risk from mercury and selenium exposure to bonytail present within the Northeast Gap Region under baseline or existing conditions. The maximum and refined tissue-based HQs were less than 1 for the surrogate fish species (rainbow trout) in the ERA (Ramboll Environ 2016c) (**Table 3.13-3**). The tissue concentration for mercury in rainbow trout was 0.1 mg/kg wet weight (maximum) and 0.09 mg/kg wet weight (refined)resulting in a maximum HQ of 0.6 and a refined HQ of 0.5. Measured selenium in fish tissue was not available for the Northeast Gap Region, but the maximum HQ for selenium modeled into representative fish was 0.4 and the refined HQ was 0.2 resulting in a conclusion that risk to fish is highly unlikely. Based on the negligible risk to bonytail in the Northeast Gap Region, the effect of mercury and selenium on baseline fish tissue concentrations are expected to be negligible.

Table 3.13-3 Northeast Gap Risk Results for Bonytail Using Surrogate Species Data (Existing Conditions)

Metal	Tissue Concentration (mg/kg wet weight)		HQ	
	Maximum	Refined	Maximum	Refined
Mercury	0.12	0.09	0.6	0.5
Selenium	*0.84*	*0.33*	0.4	0.2

Note: Values presented in italicized text indicate that measured tissue data are not available; concentrations are based on modeled result using site-specific uptake factor and surface water concentration.

3.13.3.1.2.2 Colorado Pikeminnow

<u>Species Occurrence</u>

Colorado pikeminnow were once widespread in the large rivers of the Colorado River Basin and its major tributaries (Gunnison, White, Yampa, Dolores, San Juan, Uncompahgre, Animas, and Green rivers), from Mexico and Arizona to Wyoming) (USFWS 2016a, 2002b). By the mid-1980s Colorado pikeminnow occurred only in Upper Colorado River basin of Colorado, Utah, New Mexico, and Wyoming; mainly in the Green River in Utah and in the Yampa and Colorado rivers in Colorado and portions of Utah. The species has not been collected below Glen Canyon Dam since 1968. Adults predominate in the White and Yampa rivers, while young fish is the most abundant life stage in the Green River (USFWS 2016a).

Colorado pikeminnow is represented by three wild populations, which occur in the Green River, upper Colorado River, and the San Juan River subbasins (NatureServe 2013b). The species is found in approximately 1,029 miles of riverine habitat in these three subbasins (USFWS 2011a). The population estimate for the Green River is approximately 4,500 adults in 2009, while the Colorado River estimate in 2006 was approximately 750 fish (USFWS 2011a). The wild population in the San Juan River subbasin is relatively small with 19 to 50 wild fish (Bestgen et al. 2010). The population trend over the last 10 years has been relatively stable (NatureServe 2013b). The self-sustaining population estimates are 2,600 adults for the Green River and 700 adults for the Upper Colorado River (USFWS 2011a). A target of 1,000 age 5 fish or older has been established for the San Juan River through augmentation and/or natural reproduction (USFWS 2011a). Abundance information for the portions of the action area analyzed for Colorado pikeminnow is provided below.

Lake Powell

Two Colorado pikeminnow were captured in the Colorado River arm of Lake Powell in 2014. The fish traveled 143 and 144 miles to Lake Powell from their stocking locations (Francis 2014). In 2011 and 2012, 25 Colorado pikeminnow were captured in the San Juan River arm of Lake Powell below the waterfall. A large waterfall exists where the river enters Lake Powell when the elevation is below 3,661 feet, which prevents upstream movement of fish after they have entered the lake. Sampling below the waterfall in 2015 captured 15-Passive Integrated Transponder (PIT) tagged pikeminnow (McKinstry et al. 2016). Both marked (stocked) and unmarked (stocked or wild) fish have been captured; however, capture efforts are not targeting Colorado pikeminnow because they usually do not survive capture by nets. Captured fish usually are in poor condition. Colorado pikeminnow have not been detected in the 20-km Near-field ERA analysis area including the lower portion of Lake Powell near the NGS pump station and intakes. The Colorado River inflow area to Lake Powell is considered part of the Northeast Gap area, since the Near-field ERA analysis area does not extend to the arms of the lake.

Northeast Gap Region

Based on abundance information provided in the recovery goals document (USFWS 2002b), 600 to 900 Colorado pikeminnow individuals are estimated to occur in the Colorado River subbasin. Recent estimates of Colorado pikeminnow in the Colorado River indicated an upward trend, with adult abundance increasing from approximately 200 to 890 adult fish in the period from 1992 to 2005 (Osmundson and White 2009; USFWS 2011a). In years when surveys were conducted, the population estimate was more than 700 in 1993, 2000, and 2005.

San Juan River

The Colorado pikeminnow population in the San Juan River primarily consists of stocked juvenile fish; adults are rare in occurrence (Durst and Franssen 2014). Approximately 3.2 million pikeminnow were stocked between 2002 and 2011 (USFWS 2015a). The duration of pikeminnow that have been in the river for one or more winters has shown an increasing trend since 2003. This trend is the result of fish ages dominated by 1st year or 1-year or older fish. The number of larger fish is small, although their numbers have increased. Schleicher and Ryden (2013) estimated approximately 1,000 pikeminnow with total lengths greater than 300 millimeters. The wild population in the San Juan River subbasin is relatively small, with 19 to 50 wild fish (Bestgen et al. 2010).

Verde River

An experimental, non-essential Colorado pikeminnow population has been designated in the Verde River below Sullivan Lake to Beasley Flat in Arizona. This section of the river is located upstream of the STS ROW crossing of the Verde River. There is no evidence of a self-sustaining population of Colorado pikeminnow in the Verde River. Sporadic stockings have occurred over the past several decades, but there has never been evidence of reproduction or survival of stocking individuals past a year or two post-stocking.

Life History and Habitat Association

Habitat requirements of Colorado pikeminnow vary depending on the life stage and time of year. Young-of-year and juveniles prefer shallow backwaters, while adults use pools, eddies, and deep runs that are maintained by high spring flows (USFWS 2002b). During peak runoff in the spring and early summer, fish usually move into backwater areas of flooded riparian zones to avoid swift velocities, feed, and prepare for the upcoming spawning period. Survey efforts for Colorado pikeminnow in the Green River during high flow periods consisted of nearshore areas, flooded tributary mouths, canyon washes, and large backwater areas (Bestgen et al. 2010).

Adults are highly mobile during the spawning period, which occurs after peak runoff in mid-June to mid-August. Movements have been documented up to 400 miles and involved multiple rivers within the Upper Colorado River Basin (i.e., Green and Colorado rivers) (Osmundson and White 2009). In the San Juan River, Colorado pikeminnow move long-distances upstream from spring to summer, and then move back downstream in the winter (Durst and Franssen 2014). Spawning activity begins after the peak of spring runoff at water temperatures typically 16°C or higher (USFWS 2002b).

Listing and Conservation Status

Colorado pikeminnow was listed as endangered on March 11, 1967 (32 Federal Register 4001). With the passage of the ESA in 1973, this fish species retained its endangered status. On March 21, 1994, the USFWS designated six reaches of the Colorado River system as critical habitat for the species (59 Federal Register 13374). Critical habitat consists of three primary constituent elements: water (temperature, turbidity, and lack of contaminants), physical (areas used for spawning, feeding, rearing within the 100-year floodplain), and biological environment (adequate food supply and ecologically appropriate levels of predation and competition (USFWS 1994).Critical habitat is designated in portions of the Colorado, Green, Yampa, White, and the San Juan rivers. In total, 1,148 miles of critical habitat for Colorado pikeminnow exists in these six reaches. Two of these reaches overlap with portions of the action area that were analyzed for this species. This includes the Northeast Gap Region, which contains 48.8 miles of critical habitat. The other reach is the San Juan River, which contains 233.3 miles of critical habitat. In addition, two reintroduced Colorado pikeminnow populations have been designated as Experimental/Non-essential in the Verde and Salt rivers in Arizona under 10(j) of the ESA (50 Federal Register 12 30188).

A recovery plan for Colorado pikeminnow was published in 2002 (USFWS 2002b). As part of the recovery process, 5-year reviews have been conducted to evaluate whether the status of the species has changed since its original listing in 1967. The most recent recovery review in 2011 indicated that there is a moderate degree of threat and a high degree of recovery potential at the species level taxonomically (USFWS 2011a). Recovery of the species is considered necessary only in the Upper Colorado Basin (Green River, upper Colorado River, and San Juan River subbasins); historic populations for this species in the Lower Colorado River Basin are extirpated. Colorado pikeminnow will be considered eligible for downlisting from endangered to threatened and for removal from ESA protection when all of the following conditions are met:

- Self-sustaining fish populations reach the required numbers in the areas of the Green River, Upper Colorado River, and San Juan River subbasins;
- Essential habitats, including required instream flows, are legally protected; and
- Other identifiable threats that could significantly affect the population are removed.

Factors Affecting Species

Colorado pikeminnow occurs throughout the Northeast Gap Region, which includes Lake Powell upstream to the Colorado River confluence with the Green River). Habitat in this area consists of Lake Powell, slow-moving inflow areas in the Colorado arm, and relatively narrow riverine reaches with flow. A major portion of the Northeast Gap Region consists of Cataract Canyon, where the upper section of the canyon consists of large eddy/pool complexes interspersed between large rapids. Some of the larger pools are 75 feet deep. The lower 32 miles of Cataract Canyon are inundated by Lake Powell at full-pool elevation (Badame 2008). Limiting habitat factors in the Northeast Gap Region would be the same as discussed for bonytail.

Habitat types in the San Juan River below Navajo Dam vary in terms of channel characteristics. From Navajo Dam in New Mexico downstream to Farmington, the river is restricted to a single, moderately incised channel with a mixture of riffles, deep runs, and large pools (New Mexico Department of Game and Fish 2006). As the river progresses from Farmington to Shiprock, the gradient diminishes but flow primarily remains in a single channel. Downstream of Shiprock, the river frequently is divided among two to four channels with a more complex habitat diversity including backwaters, embayments, and shoals in combination with riffle, run, and pool habitats. The San Juan River flows approximately 120 miles in Utah before it enters Lake Powell. The portion of the river from the Arizona state line to Chinle Creek is characterized as a relatively broad and braided channel. From Chinle Creek to the San Juan arm of Lake Powell, the river channel meanders and cuts through steep canyons.

Factors affecting existing conditions in the San Juan River are described in the Four Corners Power Plant and Navajo Mine Energy Biological Opinion (USFWS 2015a). A summary of these factors is provided below. These factors are applicable to the Colorado pikeminnow and its critical habitat in the San Juan River. It is important to note that the Proposed Action's potential effects to the San Juan River are limited to water quality effects from the deposition of stack releases.

Water Quality – This factor applies to Colorado pikeminnow and the water element of its critical habitat. Water quality issues in the San Juan River include metals, sediment, salinity, temperature, fecal matter, and dissolved oxygen. A discussion of the baseline water quality conditions with a focus on metals from the San Juan River ERA (Ramboll Environ 2016b) is provided in Water Resources Section 3.7.3.2, NGS and Associated Facilities. Land uses within the basin contribute metals, salts, fossil fuel residuals (e.g., polycyclic aromatic hydrocarbons), and pesticides to the San Juan River and its tributaries. Irrigation and mineral development have been identified as major sources of pollution. Fish consumption advisories for mercury in fish tissue have been issued for Navajo Reservoir and other smaller reservoirs in the basin (New Mexico Environment Department 2012; fishadvisoryonline.epa.gov/Advisories.aspx). Reviews by the USFWS (2012c; 2011a) have identified pesticides and other pollutants as potential contaminants to Colorado pikeminnow and razorback sucker. Osmundson and Lusk (2011), AECOM (2013), and Electric Power Research Institute (2014) identified mercury and selenium as moderately elevated contaminants of concern in biota and fish tissues collected from the San Juan River Basin.

Water Temperature – This factor applies to Colorado pikeminnow and the water element of its critical habitat. Navajo Reservoir affects water temperatures in the San Juan River as a result of cold-water releases. Summer water temperatures are colder and winter temperatures are warmer in comparison to pre-dam construction. The cold water released from Navajo Reservoir limits the potential spawning habitat of the endangered fishes in the San Juan River. Although Colorado pikeminnow currently occurs in the San Juan River from near the confluence of the Animas River downstream to Lake Powell, temperatures are rarely over 59ºF during pikeminnow spawning season, which is too cold for successful spawning. Spawning is unlikely to occur from Navajo Dam to the confluence of the Animas River (approximately 72 km [45 miles] below the dam) and also may be delayed for 2 weeks or more from the confluence with the Animas River down to Shiprock, New Mexico.

Fish Passage Blockage – This factor applies to the species and the physical element of its critical habitat. Colorado pikeminnow can navigate throughout the San Juan River from a waterfall in the San Juan arm upstream to Hammond Diversion Dam. The waterfall barrier is a blockage to upstream fish movement during most years when Lake Powell water levels do not inundate the sandstone ledge. During a wetter year, which occurs approximately once every 10 years, the waterfall is inundated and fish can pass above this barrier at a Lake Powell water surface elevation of 3,661 feet (USFWS 2015a). The Navajo Dam represents the furthest upstream blockage in the San Juan River. Within the San Juan River, fish passage was once impeded by five instream structures. One of these structures (Cudei Diversion at river mile 142) has been removed, two have been equipped with fish passage structures (Hogback Diversion at river mile 158.7 and Public Service Company of New Mexico Weir at river mile 166), and the Fruitland Irrigation Canal at river mile 178.5 remain as impediments to fish passage for part of the year depending on flow. The Four Corners Power Plant Project included fish passage around the

Four Corners Power Plant Diversion at river mile 163.3. However, no remaining structures are complete barriers within critical habitat.

Water Diversions and Withdrawals – Flow changes from diversions and withdrawals in the San Juan River apply to Colorado pikeminnow and the physical element of its critical habitat. Significant depletions and redistribution of flows of the San Juan River have occurred because of other major water development projects, including the Navajo Indian Irrigation Project and the San Juan-Chama Project. In addition, the Navajo-Gallup Water Supply Project would divert 35,893 acre-feet per year, with diversions to be initiated in 2024. At the current level of development, average annual flows at Bluff, Utah, already have been depleted by 30 percent. Water depletion projects that were in existence prior to November 1, 1992, are considered to be historic depletions because they occurred before the initiation of the San Juan River Recovery Implementation Program. The depletions associated with the Four Corners Power Plant and Navajo Mine are considered historic depletions, as diversion and consumptive use associated with Permit 2838 have been part of the basin depletions since the 1960s. Projects that began after this date are considered new projects. On May 21, 1999, the USFWS determined through Section 7 consultation that new depletions of 100 acre-feet or less, up to a cumulative total of 3,000 acre-feet per year, would not: 1) limit the provision of flows identified for the recovery of the Colorado pikeminnow and razorback sucker; 2) be likely to jeopardize the endangered fish species; or 3) result in the destruction or adverse modification of their critical habitat. Consequently, any new depletion under 100 acre-feet per year, up to a cumulative total of 3,000 acre-feet per year, may be incorporated under the 1999 Biological Opinion but would still require ESA consultation. Consultations contributing to the baseline depletions used reoperation of Navajo Reservoir in accordance with the flow recommendations as part of their Section 7 compliance. Some of these projects have been completed (e.g., Public Service Company of New Mexico Water Contract with Jicarilla Apache Nation), some are partially complete (e.g., Navajo Indian Irrigation Project), and some have not been fully implemented (e.g., Animas-La Plata Project). One Navajo Nation project that has been completed is the Farmington to Shiprock Pipeline Project, which diverts 4,680 acre-feet per year.

Flow Changes – The construction of Navajo Dam decreased peak discharges in the San Juan River by more than 50 percent and elevated base flows by about 168 percent on average. The USFWS (2006, as cited in USFWS 2015a) estimated that flows in the San Juan River at Bluff, Utah were reduced by 30 percent, which contributed to the decline of Colorado pikeminnow and razorback sucker. Flow recommendations were developed through the San Juan River Recovery Implementation Program during the 1990s to support habitat for native fish species. Navajo Dam has been operated to meet these flow recommendations since the completion of an EIS and Biological Opinion in 2006 (Reclamation 2006; USFWS 2006). The Biological Opinion indicated that the reoperation of the dam provides native fish with the proper cues at the proper times to trigger spawning and appropriate habitat at the appropriate time to support young fish.

Transformation of Riverine Habitat to Lake Habitat – This factor applies to Colorado pikeminnow and the physical element of its critical habitat. The addition of Navajo Reservoir and Lake Powell inundated approximately 54 and 27 miles, respectively, of the San Juan River. The inundated area reduced the total available habitat by over 30 percent.

Channel Morphology – This factor applies to Colorado pikeminnow and the physical element of its critical habitat. The San Juan River channel has narrowed considerably since the 1930s as a result of habitat degradation and erosion. The lack of flood flows also has resulted in the development of non-native riparian vegetation, which encroaches on the river and contributes to further channel narrowing. The amount of backwater habitat has decreased since 1992. The operation of Navajo Dam has been modified to include flows that would assist in maintaining channel morphology and the formation of backwaters. However, some of the flow recommendation targets have not been met since 2005 due to droughts in the basin. The last time the target number of days of flow of 8,000 and 5,000 cubic feet per second were met was in 2008. The 2,500-cubic feet per second flow target has been met consistently since 2003 (Reclamation 2012).

Entrainment/Impingement – This factor applies to Colorado pikeminnow, but there is no connection with elements of its critical habitat. Colorado pikeminnow early life stages have been adversely affected from water diversions that entrain or impinge fish on intake screens. This was an impact issue for the Four Corners Power Plant and the Arizona Public Service Company Weir, as well as other irrigation and water withdrawal structures. Arizona Public Service Company and all withdrawal structures are required to undertake all appropriate measures to reduce impacts from impingement and entrainment at the intake facilities. As an existing facility, Arizona Public Service Company also is required to comply with one of seven options to reduce entrainment, and must meet site-specific entrainment standards as required by the Director of USEPA.

Four Corners Power Plant Conservation Measures – As part of the Biological Opinion for the Four Corners Power Plant and the Navajo Mine Energy Project, conservation measures were required to offset project effects on Colorado pikeminnow, razorback sucker, and yellow-billed cuckoo in the San Juan River (USFWS 2015a). A summary of these measures is provided in Section 3.0 of this EIS in the Four Corners Power Plant and Navajo Mine discussion. These measures are relevant to Colorado pikeminnow and razorback sucker, because they are being implemented to offset project impacts related to water quality (mercury, selenium, and temperature), entrainment and impingement, and biological factors involving non-native fish competition and predation. The measures also involve the following actions to assist in the recovery of the species: propagation of endangered fish, removal of non-native fish, protection and augmentation of fish habitat, funding of fish passage at the Arizona Public Service Company Weir, Colorado pikeminnow mercury tissue studies, water temperature effects study on Colorado pikeminnow, and support of the San Juan River Basin Recovery Implementation Program.

Ecological Risk

Colorado pikeminnow were evaluated in the Gap Regions ERA by comparison of measured fish tissues concentrations, where available, to CBRs protective of fish health. Modeled fish tissue concentrations also were considered in the absence of measured values. The CBRs used for evaluation of special status species included: mercury 0.2 mg/kg wet weight (Beckvar 2005), selenium 2 mg/kg wet weight (USEPA 2016), and arsenic 5.5 mg/kg wet weight (Jarvinen and Ankley 1999), as cited in the ERAs. In the Northeast Gap, tissue data were available for mercury only. Tissue data for the other metals was modeled from surface water data.

Based on the Gap Regions ERA, there is a negligible risk from NGS metals deposition of mercury and selenium exposure to Colorado pikeminnow present within the Northeast Gap Region. Under existing (baseline) conditions, maximum and refined tissue-based HQs were less than 1 for the surrogate fish species (largemouth bass) in the ERA (Ramboll Environ 2016c) (**Table 3.13-4**). The measured tissue concentration for mercury was 0.1 mg/kg wet weight resulting in a maximum and refined HQ of 0.6. Measured selenium in fish was not available for the Northeast Gap Region, but maximum and refined HQs for representative fish (based on modeled tissue concentrations) exposed to selenium were less than 1, indicating that potential risk to fish exposed to selenium in the Northeast Gap Region is highly unlikely.

Table 3.13-4 Northeast Gap Risk Results for Colorado Pikeminnow Using Surrogate Species Data (Existing Conditions)

Metal	Tissue Concentration (mg/kg wet weight)		HQ	
	Maximum	Refined	Maximum	Refined
Mercury	0.12	0.09	0.6	0.6
Selenium	*0.84*	*0.33*	0.4	0.2

Note: Values presented in italicized text indicate that measured tissue data are not available; concentrations are based on modeled result using site-specific uptake factor and surface water concentration.

The San Juan River ERA analysis evaluated Colorado pikeminnow exposure to metals (mercury, arsenic, selenium) emissions under existing conditions using surrogate fish species tissue data (striped bass) and species-specific tissue data, where available (Ramboll Environ 2016b). The analysis based on surrogate fish tissue data for striped bass indicated that existing conditions in the San Juan River do not represent a potential risk from arsenic and selenium, based on a maximum and refined HQs less than or equal to 1 (Ramboll Environ 2016b). Maximum and refined HQs for mercury were 2 and 1, respectively (**Table 3.13-5**). When considering the results of species-specific tissue analyses for Colorado pikeminnow (**Table 3.13-6**) with maximum and refined HQs less than 1, this line of evidence indicates negligible risk to the species.

Table 3.13-5 San Juan River Risk Results for Colorado Pikeminnow Using Surrogate Species Data (Existing Conditions)

Metal	Tissue Concentration (mg/kg wet weight)		HQ	
	Maximum	Refined	Maximum	Refined
Arsenic	0.37	0.37	0.07	0.07
Mercury	0.49	0.21	2	1
Selenium	1.30	1.30	0.7	0.7

The ERA analysis considered Colorado pikeminnow tissue data in addition to surrogate fish tissue concentrations (Ramboll Environ 2016b). This ancillary analysis showed a negligible risk to Colorado pikeminnow from existing conditions, based on HQs less than 1 for arsenic, mercury, and selenium (**Table 3.13-6**). It is notable that the Colorado pikeminnow data used for this latter analysis were from stocked fish. While use of these data are appropriate, these data may underestimate baseline fish tissue concentrations for the small wild (non-stocked) fish populations, as stocked fish would have less exposure time to instream conditions compared to wild fish that have spent their entire life in the San Juan River and tissue concentrations may not be in equilibrium with current exposures. For this reason, existing conditions assessed using surrogate fish species for Colorado pikeminnow are considered more relevant to evaluate risk.

Table 3.13-6 San Juan River Risk Results for Colorado Pikeminnow Using Colorado Pikeminnow Tissue Data (Existing Conditions)

Metal	Tissue Concentration (mg/kg wet weight)		HQ	
	Maximum	Refined	Maximum	Refined
Arsenic	0.37	0.37	0.07	0.07
Mercury	0.25	0.11	1	0.5
Selenium	1.1	0.78	0.5	0.4

3.13.3.1.2.3 Humpback Chub

Species Occurrence

The historic distribution of the humpback chub is unknown, although early records reported this species in the Upper Colorado River Basin and Colorado River below Lee's Ferry (USFWS 2002c). It is estimated from various reports and collections that indicate the species presently occupies about 68 percent of its historic habitat. Six humpback chub populations are currently identified: (1) Black Rocks, Colorado; (2) Westwater Canyon, Utah; (3) Little Colorado River and Colorado rivers in Grand Canyon, Arizona; (4) Yampa Canyon, Colorado; (5) Desolation/Gray Canyons, Utah; and (6) Cataract Canyon, Utah. Each population consists of a discrete group of fish, geographically separated from the other populations, but with some exchange of individuals. River length occupied by each population varies from 2.3 miles in Black Rocks to 46 miles in Yampa Canyon.

Humpback chub is represented by six populations. Five of the populations occur in the upper basin recovery units listed above. The only population in the lower basin recovery unit occurs in the mainstem of the Colorado River in Marble and Grand Canyons and the Little Colorado River. The species is found in approximately 470 miles of riverine habitat in these population areas (USFWS 2011b). The estimated number of adults in the upper basin recovery units included approximately 400 at Black Rocks (Francis et al. 2016), 1,300 at Westwater Canyon (Hines et al. 2015), 1,600 at Desolation-Gray Canyons (Badame 2011), and 300 at Cataract Canyon (Badame 2008). Core populations in the upper basin include Black Rocks/Westwater Canyon and Desolation-Gray Canyon with recovery criteria of 2,100 adults. The lower basin recovery unit is a self-sustaining population, with the Grand Canyon adult population estimate of 11,000 adults (Yackuic et al 2014). The Grand Canyon and Little Colorado River population is considered a core population. Recent estimates indicate that the Grand Canyon and Little Colorado River population is stabilizing after a decade of decline (USFWS 2011b). Abundance information for the portions of the action area analyzed for humpback chub is provided below.

Northeast Gap Region

Humpback chub occurs in the Cataract Canyon portion of the Colorado River immediately upstream of Lake Powell. Population estimates in 2003 through 2005 ranged from 273 to 468 individuals in Cataract Canyon (Badame 2008). Growth rates and condition factors for humpback chub in these Cataract Canyon surveys were the lowest values observed for any of the populations in the Colorado River Basin.

Southwest Gap Region

Humpback chub occurs from river mile 30 downstream and throughout the Colorado River in the Grand Canyon, with the highest densities within and adjacent to the Little Colorado River at approximate river mile 62. It is noted that these river mileages start at 0 at Lees Ferry, which is approximately 16 river miles below Glen Canyon Dam. Thus, the first recognized chub population begins at river mile 30 is actually approximately 46 river miles below Glen Canyon Dam. The Grand Canyon humpback chub population has shown increasing trends in numbers since 2001 (Bureau of Reclamation and National Park Service [NPS] 2015). The population is currently estimated at 11,000 adults compared to a population low of 5,000 in 2001 (Yackulic et al. 2014). Approximately 300 humpback chub are estimated to be present at the river mile 30 aggregation.

Life History and Habitat Association

Humpback chub mainly occurs in river canyons where they utilize a variety of habitats including deep pools, eddies, upwells near boulders, and areas near steep cliff faces (NatureServe 2014). As young humpback chub mature, they shift toward deeper and swifter offshore habitats (USFWS 2002c). Within the Grand Canyon, humpback chub occurs primarily in the vicinity of the Little Colorado River confluence, with adults being associated with large eddy complexes. Converse et al. (1998) reported that subadult humpback chub in the Colorado River downstream of the Little Colorado River showed higher densities along shoreline areas with vegetation, talus slopes, and debris fans.

Humpback chub are broadcast spawners with a relatively low fecundity rate compared to other minnow species of similar size (USFWS 2002c). Spawning primarily occurs in March through May in the lower basin and during April through June in the upper basin. Spawning temperatures typically range from 16ºC to 22ºC. The main spawning area for humpback chub in the Grand Canyon is the Little Colorado River, which provides warm water temperatures and shallow velocity pools for larvae (Gorman 1994). In the mainstem portion of the Colorado River, young-of-the-year fish are found in backwater and other nearshore areas that serve as nursery habitats (Valdez and Ryel 1995).

Listing and Conservation Status

Humpback chub was listed as endangered on March 11, 1967. On March 21, 1994, the USFWS designated seven reaches of the Colorado River system as critical habitat for humpback chub (USFWS 1994). As previously mentioned, critical habitat consists of three primary constituent elements: water (temperature, turbidity, and lack of contaminants), physical (areas used for spawning, feeding, rearing within the 100-year floodplain), and biological environment (adequate food supply and ecologically appropriate levels of predation and competition) (USFWS 1994). Critical habitat is designated in portions of the Colorado, Green, and Yampa rivers in the Upper Colorado River Basin and the Colorado and Little Colorado rivers in the Lower Colorado River Basin. In total, 379 miles of critical habitat exists for humpback chub in these seven reaches. Two of these reaches overlap with portions of the action area that were analyzed for this species. This includes 12.9 miles in the Northeast Gap Region and 34.2 miles in the Southwest Gap Region. The upper end of the habitat is located approximately 27 miles upstream of the confluence with the Little Colorado River.

A recovery plan for humpback chub was first published in 1990 and then amended in 2002 (USFWS 2002c). Five-year reviews of the recovery goals were initiated in 2007 for the humpback chub and the other three Colorado River system endangered fish species (72 Federal Register 19549-19551). For the purposes of recovery goals for humpback chub, the upper and lower basins are divided at the Glen Canyon Dam in Arizona. Separate objective, measurable recovery criteria were developed for each of the recovery units (i.e., the upper basin including the Green River and Upper Colorado River subbasins; and the lower basin including the mainstem of the Colorado River and its tributaries downstream to the Lake Mead National Recreation Area) for the purpose of addressing the unique threats and using site-specific management actions necessary to minimize or remove these threats. The recovery units encompass three management areas under three separate recovery or conservation programs: Upper Colorado River Endangered Fish Recovery Program, the Glen Canyon Dam Adaptive Management Program, and the Lower Colorado River Multi-Species Conservation Program. Humpback chub will be considered eligible for downlisting from endangered to threatened and for removal from ESA protection when all of the following conditions are met:

- Maintain six self-sustaining populations;
- Essential habitats, including required instream flows, are legally protected; and
- Other identifiable threats that could significantly affect the population are removed.

Factors Affecting Species

The types of aquatic habitat in the Southwest Gap Region (Glen Canyon Dam downstream to the confluence with the Little Colorado River) are influenced by geological conditions and a river with highly regulated flows and water temperatures that are perennially colder than Lake Powell inflows. Reclamation and the NPS divide the Colorado River below Glen Canyon Dam into three segments (Reclamation and NPS 2015). Beginning at Glen Canyon Dam, the first portion of the river is the 15-mile stretch that runs downstream through Glen Canyon to just upstream of the Paria River at Lees Ferry (river mile 0). Glen Canyon has a substantially different geomorphic structure compared to the reaches farther downstream, and it has a limited sediment supply. The next section of river is the approximately 62-mile stretch that runs through Marble Canyon. This stretch starts at the mouth of the Paria River at Lees Ferry (river mile 0) and extends to just upstream of the Little Colorado River confluence (river mile 61.5). The sediment load of this reach is dominated by Paria River inputs. The third section runs through the Grand Canyon and comprises the remainder of the river downstream of the Little Colorado River. The sediment load of this third portion is the cumulative supply provided by contributions from the Paria River reach, the Little Colorado River, and various other small tributaries.

Factors affecting baseline conditions in the Southwest Gap Region of the Colorado River for humpback chub are described in the draft document entitled *Glen Canyon Dam Long-term Experimental and Management Plan* (Reclamation and NPS 2015). A summary of these factors is provided below. These factors are applicable to the humpback chub and its critical habitat in the Southwest Gap Region. It is important to note that the Proposed Action's potential effects to the Colorado River below Glen Canyon Dam are limited to water quality effects from the deposition of stack releases.

Water Quality – This factor applies to humpback chub and the water element of its critical habitat. Current water quality conditions in the Colorado River below Glen Canyon Dam reflect post-dam and ongoing conditions. A discussion of the baseline water quality conditions with a focus on metals from the Gap Region ERA (Ramboll Environ 2016c) is provided in Water Resources Section 3.7.3.2, NGS and Associated Facilities. In the post-dam era, the extent of variations in temperature, salinity, turbidity, and nutrient concentrations have moderated and shown an overall improvement in water quality. The primary water input that affects the water quality below Glen Canyon Dam includes the deep water releases from Lake Powell and several large tributaries such as the Little Colorado and Paria rivers. The release of water from Lake Powell results in cooler temperatures as well as slight increases in salinity until mixing occurs in the river from larger tributaries. In general, these tributaries tend to carry water at higher temperatures than the mainstem river, thus warming the regions where they join. In addition, tributaries, such as Paria River and Little Colorado River, can carry large amounts of fine sediment and organic materials during flood events. Sediment levels in the river near the confluence with these tributaries range from 20 to 133,000 milligrams per liter depending on the season and year.

Dams and Reservoirs – This factor applies humpback chub and the water and physical elements of its critical habitat. The construction of Lake Powell and Glen Canyon Dam altered riverine habitat and resulted in coldwater releases that have affected water temperatures. Cold water temperatures in the main channel are below the temperature for spawning, egg incubation, and growth of humpback chub. The survival of humpback chub young in the mainstem portion of the river is considered to be low because of cold water temperatures. However, water temperatures in the mainstem Colorado River have generally increased over the past 10 years (approximately 1 to 4ºC maximum water temperature increase depending on the river location). Although the current water temperatures are not optimal for humpback chub, juvenile fish can now successfully rear to the adult stage. Population estimates for humpback chub in the Grand Canyon have been increasing since 2000, with suggested reasons being experimental water releases, drought-induced warming, and trout declines due to removal. This warmer water appears to have benefited the humpback chub and other native fish, but they also may have benefited non-native warmwater species (e.g., channel catfish, striped bass, and green sunfish) that are more abundant farther downstream in the Grand Canyon.

Water Diversions – Flow changes from diversions and withdrawals in the Colorado River apply to humpback chub and the physical element of its critical habitat. Numerous non-federal diversions are currently in place on the mainstem Colorado River and tributaries in Colorado and Utah, and on the San Juan River in Colorado, Utah, and New Mexico. Collectively, these ongoing diversions reduce flows in the Upper Colorado River Basin, which reduce the volume of water stored in Lake Powell.

Non-native Fish – This factor applies to humpback chub and the biological environment element of its critical habitat. The occurrence of non-native fishes in the Colorado River affects humpback chub due to predation and competition. The threat of both warmwater and coldwater non-native fish species is an issue to native fish species in Grand Canyon National Park (NPS 2013; Reclamation and NPS 2015). Green sunfish was discovered in a backwater slough below Glen Canyon Dam in 2015. Treatment was administered by the NPS and Arizona Game and Fish Department (AGFD), but some fish escaped downstream (NPS 2016). Mechanical removal of non-native rainbow and brown trout also is occurring as a multi-year project in the lower reach of Bright Angel Creek, a tributary to the Colorado River within Grand Canyon. Predation by rainbow trout and brown trout in the Little Colorado River confluence area is considered to be a mortality threat to humpback chub survival, reproduction, and recruitment. Channel catfish and black bullhead prey on humpback chub in the Grand Canyon. Because of their size, adult humpback chub are less likely to be preyed on by trout. Experimental removal of non-native brown and rainbow trout was conducted in the Colorado River in Grand Canyon between 2003 and 2006. Twenty-three trips to remove trout from the vicinity of the confluence of the Little Colorado River (river miles 56–66) resulted in the removal of more than 23,000 non-native fish (mostly rainbow trout). During this time, the rainbow trout population in the Colorado River in the vicinity of the Little Colorado River was decreased by more than 80 percent. An experimental non-native fish suppression flow regime was implemented by Reclamation in 2003 and 2004 to assist in the reduction of rainbow trout abundance. However, it was concluded that the experimental flows were not effective in limiting trout recruitment (Korman et al. 2011). In addition, the Colorado River now includes non-native fish parasites, such as the Asian tapeworm and anchor worm, which may infect some humpback chub and affect survival.

Ecological Risk

Humpback chub were evaluated in the Gap Region ERA by comparison of measured fish tissues concentrations, where available, to CBRs protective of fish health. Modeled fish tissue concentrations also were considered in the absence of measured values. The CBRs used for evaluation of special status species included: mercury 0.2 mg/kg wet weight (Beckvar 2005), selenium 2 mg/kg wet weight (USEPA 2016), and arsenic 5.5 mg/kg wet weight (Jarvinen and Ankley 1999), as cited in the Gap Region ERA (Ramboll Environ 2016c). In the Northeast Gap, tissue data were available for mercury only. Tissue data for the other metals was modeled from surface water data.

Based on the Gap Regions ERA, there is a negligible risk from mercury and selenium concentrations to humpback chub present within the Northeast Gap Region under existing conditions (Ramboll Environ 2016c). The refined tissue-based HQs were less than 1 for the surrogate fish species roundtail chub (Ramboll Environ 2016c). Tissue concentrations and the HQ was the same as listed for bonytail. Similarly, negligible risks were indicated for humpback chub in the Southwest Gap Region under existing conditions, because the tissue-based HQs for selenium and mercury were less than 1 (**Table 3.13-7**).

Table 3.13-7 Gap Region Risk Results for Humpback Chub Using Surrogate Species and Baseline Fish Tissue Data (Existing Conditions)

Metal	Tissue Concentration (mg/kg wet weight)		HQ	
	Maximum	Refined	Maximum	Refined
Northeast Gap Region				
Mercury	0.12	0.094	0.6	0.5
Southwest Gap Region				
Mercury	0.17	0.15	0.8	0.7
Selenium	0.74	0.73	0.4	0.4

3.13.3.1.2.4 Razorback Sucker

Species Occurrence

Historically, the razorback sucker occupied the mainstem Colorado River and many of its tributaries from northern Mexico through Arizona and Utah into Wyoming, Colorado, and New Mexico (USFWS 2002d). In the late 19th and early 20th centuries, it was reported that razorback sucker occurred in the Lower Colorado River Basin and common in parts of the Upper Colorado River Basin.

Existing populations of razorback sucker occur in the Green River, upper Colorado River, San Juan River subbasins; lower Colorado River between Lake Havasu and Davis Dam; Lake Mead and Lake Mohave; and in small tributaries of the Gila River subbasin (Verde and Salt rivers and Fossil Creek (USFWS 2002d). Fish in most of the populations consist of aged fish with little or no recruitment to reproductive age. Two spawning populations able to recruit to adults exist in Lake Mead and the middle Green River. In the lower basin a population occurs in Lake Mohave with approximately 2,500 fish (Wisenall et al. 2015). The Green River subbasin population is estimated to be approximately 2,500 fish (Bestgen et al. 2012). The population is very small in the Upper Colorado River, with no evidence of spawning since the 1960s (NatureServe 2013c). It is estimated that the 60-mile reach of the lower Colorado River between Davis Dam and Lake Havasu contains nearly 5,000 fish (Ehlo et al. 2016). The population estimate in Lake Mead is approximately 500 to 600 fish (Lower Colorado River Multi-species Conservation Program 2015). The Gila River subbasin populations are small and consist of stocked hatchery fish. The minimum viable population size for razorback is estimated to be 5,800 adults (USFWS 2012b, 2002d). The razorback sucker is still declining from historical records in all of the subbasins (NatureServe 2013c).

Occurrence and abundance information for the portions of the action area that were analyzed for razorback sucker is provided below. The study areas included Lake Powell, Northeast Gap Region (Colorado River above Lake Powell), Southwest Gap Region (Colorado River below Lake Powell), San Juan River, and the Verde River. The first four waterbodies are associated with the NGS deposition areas, while the Verde River is crossed by the STS.

Lake Powell

A total of 247 razorback suckers were captured in the Colorado River inflow area of Lake Powell in 2014 (Ryden 2014). Razorback sucker has been collected in Lake Powell over a large span of years (1972 to 2014 in the Colorado River arm). Many of these fish originated from stocking events in rivers upstream of the reservoir. Fish are almost always in good condition and biologists believe that they use these areas because they are productive and because increased turbidity provides protection from predators. Razorback sucker comprised approximately 3 percent of the larval fish numbers in the Colorado River arm of Lake Powell in 2014 (Brandenburg 2014). Razorback sucker also have been collected in the San Juan River arm of Lake Powell over a large span of years (1982 to 2012) (Francis et al. 2014; Travis et al. 2013). Many of these fish originated from stocking events upstream in the San Juan River. Razorback sucker do not occur in the Near-field ERA analysis area including the lower portion of Lake Powell near the NGS pump station and intakes. The Colorado River inflow is considered part of the Northeast Gap area, while the San Juan River inflow is part of the San Juan River analysis area. The Near-field ERA analysis area does not extend into the Colorado and San Juan river arms of the lake.

Northeast Gap Region

Based on monitoring surveys conducted in Cataract Canyon, razorback sucker were collected in relatively low numbers in 2008 and 2009 (Badame and Lund 2009). The species was less abundant than humpback chub.

Southwest Gap Region

Prior to 2012, razorback sucker was considered extirpated from Grand Canyon. Historic records of razorback sucker in the Southwest Gap Region includes the mouth of the Paria River (1963 and 1978), river mile 39 (1993), and the Little Colorado River inflow (1989 and 1990) (NPS 2013). However, razorback sucker currently is known to occur at scattered locations in the Colorado River from river mile 90 to river mile 260. All of these current locations are located downstream of the Southwest Gap Region study area. Cold water releases from Lake Powell likely limit razorback sucker occurrence in the segment between Glen Canyon Dam and the Little Colorado River confluence.

San Juan River

The San Juan River razorback sucker population is sustained by stocking hatchery-reared fish, with over 130,000 stocked fish since the mid-1990s (USFWS 2015a). Currently, 14,000 razorback suckers with a 300-millimeter total length are stocked annually in the San Juan River. Recent mark-recapture data indicate an increasing trend in razorback abundance. Recent population estimates were 2,000 in 2009 and 3,000 in 2010 (Duran et al. 2013). All razorback sucker collected in 2014 were stocked fish, with ages ranging from 2 to 15 years (Schleicher 2015). There is limited documented evidence that spawning and recruitment of wild fish is occurring in the San Juan River (USFWS 2015a).

Verde River

Razorback sucker have been stocked in the Verde River since 1981 in a section of the river between Perkinsville, Arizona and Horseshoe Reservoir (Hyatt 2004; Robinson 2007). Monitoring efforts recaptured introduced razorback sucker near the introduction sites. Population data are not available, but the hatchery-stocked fish usually do not persist after several years. It is unlikely that razorback sucker is present in the section of the Verde River crossed by the STS.

Life History and Habitat Association

The types of habitat used by razorback sucker vary depending on the life stage and time of year. Adults use eddies, pools, and backwaters during the nonbreeding period from July through March (Maddux et al. 1993). Seasonal habitat use includes pools and eddies from November through April, runs and pools from July through October, runs and backwaters in May, and backwaters and flooded gravel pits during June. Juveniles prefer shallow water with minimal flow in backwaters, tributary mouths, off-channel impoundments, and lateral canals (Maddux et al. 1993). In the upper basin, bottomlands, low-lying wetlands, and oxbow channels flooded and ephemerally connected to the main channel by high spring flows are important habitats for all life stages of razorback sucker. Flow recommendations have been developed to enhance habitat complexity and restore and maintain ecological processes. In the Lower Colorado River Basin, adult razorback sucker utilize open-water areas except in the breeding season when they congregate in shallow, nearshore areas (USFWS 2002d). Larval razorback sucker in Lake Mohave occupied vegetated areas near the shore.

Spawning occurs in February through mid-June when adult razorback sucker congregate in flooded bottomlands and gravel pits, backwaters, and impounded tributary mouths near spawning sites (USFWS 2002d). Thermal preference for spawning is 22ºC to 25ºC. Razorback sucker typically migrate a long distance in large numbers during the spawning period.

Listing and Conservation Status

The razorback sucker was first proposed for listing as a threatened species under the ESA in 1978 (43 Federal Register 17375). In 1980, the USFWS withdrew the proposal because it was not finalized within the 2-year time limit from the initial publication in the Federal Register (45 Federal Register 35410). In 1989, the USFWS received a petition requesting that the razorback sucker be added to the list of endangered species. A positive finding was made and subsequently published by the USFWS in 1991 (56 Federal Register 54957). In 1994, the USFWS designated 15 reaches of the Colorado River system as critical habitat (USFWS 1994). Critical habitat consists of three primary constituent elements: water (temperature, turbidity, and lack of contaminants), physical (areas used for spawning, feeding, rearing within the 100-year floodplain), and biological environment (adequate food supply and ecologically appropriate levels of predation and competition) (USFWS 1994). Critical habitat is designated in portions of the Green, Yampa, Duchesne, Colorado, White, Gunnison, and San Juan rivers in the Upper Colorado River Basin and the Colorado and Little Colorado rivers in the Lower Colorado River Basin. Critical habitat in the Colorado River includes reaches in the Upper Colorado River Basin (above and below Westwater Canyon in Colorado and Utah and the Lower Colorado River Basin from the confluence with the Paria River to Hoover Dam). In total, 1,724 miles of critical habitat for razorback sucker has been designated. Critical habitat overlaps with portions of the action area that were analyzed for this species. This includes 48.8 miles in the Northeast Gap Region, 68.4 miles in the Southwest Gap Region, and 211.1 miles in the San Juan River. Critical habitat in the Verde River extends between Perkinsville, Arizona and Horseshoe Reservoir. The Verde River critical habitat for razorback sucker is located approximately 10 miles downstream of the STS ROW crossing of the Verde River.

A recovery plan for razorback sucker was first published in 1990 and then amended in 2002 (USFWS 2002d). Recovery of razorback sucker in the Colorado River Basin is considered necessary in both the upper and lower basins because of the present status of populations and existing information on razorback sucker biology. The upper basin recovery unit is composed of the Green River, Upper Colorado River, and San Juan River subbasins. The lower basin recovery unit includes the mainstem and tributaries of the Colorado River from Lake Mead downstream to the International Boundary with Mexico (USFWS 2002d). Razorback sucker will be considered eligible for downlisting from endangered to threatened and for removal from ESA protection when all of the following conditions are met:

- Maintain self-sustaining populations in the Green River subbasin and either the Upper Colorado River subbasin or the San Juan River subbasin in the upper basin recovery unit;
- Maintain two genetically and demographically self-sustaining populations in the lower basin recovery unit;
- Maintain a genetic refuge in Lake Mohave;
- Essential habitats, including required instream flows, are legally protected; and
- Other identifiable threats that could significantly affect the population are removed.

Factors Affecting Species

Habitat conditions in areas inhabited by razorback sucker in the Northeast Gap Region, Southwest Gap Region, and San Juan River are discussed above in the baseline characterization section for bonytail, humpback chub, and Colorado pikeminnow, respectively, for these study areas. Additional information regarding factors affecting razorback sucker in the Southwest Gap Region is provided below.

Based on information in the Glen Canyon Dam Long-term Experimental and Management Plan (Reclamation and NPS 2015), the decline of the razorback sucker throughout its range has been related primarily to habitat loss due to dam construction, loss of spawning and nursery habitats as a result of diking and dam operations, and alteration of flow hydrology. It is estimated that approximately 80 percent of the reduction in the historical distribution of this species has been attributed to the construction of Hoover, Parker, Davis, and Glen Canyon Dams on the Colorado River and Flaming Gorge Dam on the Green River. In addition, competition with and predation by non-native fishes also have been identified as important factors in the decline of this species, as discussed for humpback chub. In the Grand Canyon, the decline of native fish, including razorback sucker, has been attributed in large part to an increased diversity and abundance of non-native fishes along with the effects of Glen Canyon Dam on water temperatures, flow, and sediment (Gloss and Coggins 2005).

Ecological Risk

Razorback sucker were evaluated in the Gap Regions ERA by comparison of measured fish tissues concentrations, where available, to CBRs protective of fish health. Modeled fish tissue concentrations also were considered in the absence of measured values. The CBRs used for evaluation of special status species included: mercury 0.2 mg/kg wet weight (Beckvar 2005), selenium 2 mg/kg wet weight (USEPA 2016), and arsenic 5.5 mg/kg wet weight (Jarvinen and Ankley 1999), as cited in the ERAs. In the Northeast Gap, tissue data were available for mercury only. Tissue data for the other metals was modeled from surface water data.

There is a negligible risk from mercury and selenium baseline concentrations present in fish tissue within the Northeast Gap Region for razorback sucker, as indicated by the maximum and refined tissue-based HQ being less than 1 for the surrogate species, channel catfish (Ramboll Environ 2016c) (**Table 3.13-8**). The maximum and refined tissue concentration for mercury was 0.1 mg/kg wet weight with a maximum and refined HQ of 0.5. Measured selenium in fish was not available for the Northeast Gap Region, but the maximum and refined HQs for representative fish exposed to selenium was 0.4 and 0.2, respectively.

Table 3.13-8 Northeast Gap Risk Results for Razorback Sucker Using Surrogate Species Data (Existing Conditions)

Metal	Tissue Concentration (mg/kg wet weight)		HQ	
	Maximum	Refined	Maximum	Refined
Mercury	0.1	0.09	0.5	0.5
Selenium	*0.84*	*0.33*	0.4	0.2

Note: Values presented in italicized text indicate that measured tissue data are not available; concentrations are based on modeled result using site-specific uptake factor and surface water concentration.

Baseline fish tissue concentrations in the Southwest Gap Region represent a potential risk to razorback sucker from mercury concentrations, based on tissue-based HQs exceeding 1 (Ramboll Environ 2016c). Razorback sucker maximum (HQ = 5) and refined (HQ = 3) methyl mercury HQs exceeded 1 using flannelmouth sucker as a surrogate species; however, the maximum and refined HQs were less than or equal to 1 using an alternate surrogate, the bluehead sucker (**Table 3.13-9**). Baseline selenium concentrations indicated negligible potential risks to razorback sucker because measured selenium tissue-based HQs were equal to 1 for the surrogate, flannelmouth sucker; and the HQ was below 1 using an alternate surrogate, the bluehead sucker.

Table 3.13-9 Southwest Gap Region Risk Results for Razorback Sucker Using Surrogate Species and Baseline Fish Tissue Data (Existing Conditions)

	Tissue Concentration (mg/kg wet weight)				HQs			
	Bluehead Sucker		Flannelmouth Sucker		Bluehead Sucker		Flannelmouth Sucker	
Metal	Maximum	Refined	Maximum	Refined	Maximum	Refined	Maximum	Refined
Mercury	0.21	0.16	0.98	0.67	1	0.8	5	3
Selenium	1.5	1.3	2.9	2.5	0.8	0.7	1	1

In the San Juan River, there is negligible risks from arsenic, mercury, or selenium under existing conditions using flannelmouth sucker and bluehead sucker as surrogates for razorback sucker, because the tissue-based HQs were less than 1 (Ramboll Environ 2016b) (**Table 3.13-10**).

Table 3.13-10 San Juan River Risk Results for Razorback Sucker Using Surrogate Species and Baseline Fish Tissue Data (Existing Conditions)

	Tissue Concentration (mg/kg wet weight)				HQs			
	Bluehead Sucker		Flannelmouth Sucker		Bluehead Sucker		Flannelmouth Sucker	
Metal	Maximum	Refined	Maximum	Refined	Maximum	Refined	Maximum	Refined
Arsenic	0.36	0.20	0.32	0.10	0.06	0.04	0.06	0.02
Mercury	0.10	0.05	0.27	0.11	0.5	0.2	1	0.6
Selenium	1.60	0.61	2.50	0.81	0.8	0.3	1	0.4

The ERA analysis also included an analysis using razorback sucker tissue data rather than surrogate fish tissue concentrations (Ramboll Environ 2016b). This analysis also showed negligible risks to the species, based on HQs less than 1 for arsenic, mercury, and selenium (**Table 3.13-11**). It is notable that the razorback sucker data used for this latter analysis were from stocked fish. While use of these data are appropriate, these results may underestimate baseline tissue concentrations for wild (non-stocked) fish populations, as stocked fish would have less exposure time to instream conditions compared to wild fish that have spent their entire life in the San Juan River. For this reason, baseline conditions assessed using surrogate fish species for razorback sucker may be of equal relevance to “frame” the potential risk outcome.

Table 3.13-11 San Juan River Risk Results Using Razorback Sucker Tissue and Baseline Fish Tissue Data (Existing Conditions)

Metal	Tissue Concentration (mg/kg wet weight)		HQ	
	Maximum	Refined	Maximum	Refined
Arsenic	0.34	0.22	0.06	0.04
Mercury	0.15	0.09	0.7	0.4
Selenium	2.30	0.95	1	0.5

3.13.3.1.2.5 Kanab Ambersnail

Species Occurrence

The historic distribution of the terrestrial snail Kanab ambersnail (*Oxyloma haydena kanabensis*) is limited to Kanab and Three Lakes canyons near Kanab, Utah ((Meretsky et al. 2002). Currently the species is known to exist at two locations within the Southwest Gap Region. One wild or natural population is present in a riverside spring called Vasey's Paradise within Grand Canyon National Park (AGFD 2013a). One introduced extant population also occurs in Upper Elves Canyon within Grand Canyon National Park. Critical habitat has not been designated for the species. The estimated population size at Vasey's Paradise ranged from approximately 3,100 to 104,000 individuals (USFWS 2011c). Population counts were highly variable due to temporal and spatial population densities, sampling error, and variability in sampling methods (USFWS 2011c). Occupied and potential habitat for the Vasey's Paradise population also has varied, with the maximum estimated area of 9,699 feet^2 (USFWS 2011c). The AGFD translocated 340 Kanab ambersnails from Vasey's Paradise to Upper Elves Canyon in 1998 and 2002.

Life History and Habitat Association

Kanab ambersnail is associated with vegetation in spring areas. Habitat at the Vasey's Paradise site consists of a cool spring that flows directly from limestone down a steep gradient to the mainstem of the Colorado River (USFWS 2011c). Within large patches of mixed vegetation composed primarily of crimson monkeyflower (*Mimulus cardinalis*), watercress (*Nasturtium officinale*), and sedge (*Carex aquatilus*), the snail inhabits dead and decaying monkeyflower litter and live watercress. The Upper Elves Canyon site is a spring area dominated by monkeyflower and maidenhair fern (*Adiantum cappillus-veneris*).

Listing and Conservation Status

Kanab ambersnail was proposed for federal endangered listing in November 1991 (56 Federal Register 58020-58025). The final rule for endangered status was published in April 1992 (57 Federal Register 13657-13662), although a correction was made in September 1992 (57 Federal Register 44340).

A recovery plan for the Kanab ambersnail was issued in October 1995, with the first 5-year review completed in 2011 (USFWS 2011c). The review indicated that the Kanab ambersnail faces a high degree of threat from the modification of wetland habitat, and the recovery potential is low due to conflict with private land development projects.

Factors Affecting Species

Factors affecting Kanab ambersnail include the modification of wetland habitats and private land development activities that reduce or alter habitat for this species.

Ecological Risk

Ecological risk from NGS and the proposed KMC emissions is not expected because Kanab ambersnail occurs in wetland or spring areas located outside of the Colorado River channel. These areas are not impacted by deposition or runoff into the mainstem of the Colorado River.

3.13.3.1.3 Other Special Status Aquatic Species

Other special status aquatic species that occur within the NGS Near-field deposition area, Gap Regions, and San Juan River are listed in **Table 3.13-12**. The additional species include three fish (bluehead sucker, flannelmouth sucker, and speckled dace) and one amphibian (northern leopard frog). Three federally listed fish species (Colorado pikeminnow, humpback chub, and razorback sucker), also are Navajo endangered species and Arizona Species of Special Concern. Other native fish species that occur in the NGS study areas include roundtail chub (Colorado and San Juan rivers), speckled dace (Gap Regions and San Juan River), and redside shiner (Colorado River Northeast Gap Region). The roundtail chub is a Navajo endangered species.

Table 3.13-12 Other Special Status Aquatic Species in the Lake Powell, Colorado River Gap Regions, and San Juan River Analysis Areas

Species	Status[1]	Lake Powell	Colorado River Northeast Gap Region	Colorado River Southwest Gap Region	Lower San Juan River
Fish					
Bluehead sucker	SGCN, NME		X	X	X
Flannelmouth sucker	SGCN	X	X	X	X
Roundtail chub	NESL G2		X[2]		X
Speckled dace	BLMS, SGCN		X	X	X
Amphibians					
Northern leopard frog	BLMS, NESL G2, SGCN			X	

1 Status = BLMS = BLM Sensitive; NESL = Navajo Endangered Species List (G2 and G3); SGCN = Arizona Species of Greatest Conservation Need; NME = New Mexico Endangered Species.

2 Species occurrence in study area; however, the study area is not within or adjacent to Navajo Nation land.

3.13.3.2 Proposed Kayenta Mine Complex

No federally listed, proposed, or candidate aquatic species occur within the proposed KMC and N-Aquifer groundwater study area. Potential habitat for one special status aquatic species (Navajo Nation endangered), northern leopard frog, is present within the proposed KMC N-Aquifer groundwater study area. Historic records exist for northern leopard frog in Cow Springs; however, no recent occurrence has been documented (Smith and Hazelton 2014).

3.13.3.3 Transmission Systems and Communication Sites

Table 3.13-13 provides a list of special status fish, amphibians, and aquatic invertebrate species that have habitat crossed by the WTS and STS ROWs. Eight federally listed fish species (desert pupfish, Gila chub, Gila topminnow, loach minnow, razorback sucker, spikedace, Virgin River chub, and woundfin) and one proposed for listing (roundtail chub) occur in streams crossed by the transmission lines. Critical habitat is crossed by the transmission system ROWs for four fish species (loach minnow, spikedace, Virgin River chub, and woundfin) (**Figure 3.13-2**). Twelve additional aquatic species (desert sucker, flannelmouth sucker, Meadow Valley Wash desert sucker, Meadow Valley Wash speckled dace, Moapa speckled dace, speckled dace, Virgin spinedace, Arizona toad, Great Plains toad, western boreal toad, northern leopard frog, and Niobrara ambersnail) with special status related to either BLM sensitive, Forest sensitive, Navajo endangered, or Arizona or Nevada protected have known or potential habitat within the ROWs for the WTS and STS. The following information provides a summary of occurrence, critical habitat, habitat preferences, life history, and conservation status for the federally listed species.

Table 3.13-13 Special Status Aquatic Species Occurring in Streams Crossed by the Transmission Systems

Common Name	Scientific Name	Status[1]	WTS	STS	Streams
Fish					
Colorado pikeminnow	*Ptychocheilus lucius*	EXP/NE		K	Verde River
Desert pupfish	*Cyprinodon macularius*	FE		K	Agua Fria River
Desert sucker	*Catostomus clarkii*	BLMS	K		Virgin River
Gila chub	*Gila intermedia*	FE		K	Agua Fria River
Gila topminnow	*Poeciliopsis occidentalis*	FE		K	Agua Fria River
Flannelmouth sucker	*Catostomus latipinnis*	BLMS, FS	K		Colorado and Virgin rivers
Loach minnow	*Rhinichthys cobitis*	FE		K (CH)	Verde River
Meadow Valley Wash desert sucker	*Catostomus clarkia* subspecies	BLMS, NV-P	K		Meadow Valley Wash and Muddy River
Meadow Valley Wash speckled dace	*Rhinichthys osculus* subspecies	BLMS, NV-P	K		Meadow Valley Wash and Muddy River
Moapa speckled dace	*Rhinichthys osculus moapae)*	NV-P	K		Muddy River
Razorback sucker	*Xyrauchen texanus*	FE		K	Verde River
Roundtail chub	*Gila robusta*	FPT, NESL G2		K	Verde River
Speckled dace	*Rhinichthys osculus*	BLMS	K	P	Colorado, Paria, Verde, and Virgin rivers
Spikedace	*Meda fulgida*	FE		K (CH)	Verde River
Virgin River chub	*Gila seminuda*	FE	K (CH)		Muddy and Virgin rivers
Virgin spinedace	*Lepidomeda mollispinis mollispinis*	BLMS, NV-P, CA	K		Virgin River
Woundfin	*Plagopterus argentissimus*	FE	K (CH)		Virgin River
Amphibians					
Arizona toad	*Anaxyrus microscaphus*	BLMS	K		Muddy and Virgin rivers (breeding period)
Great Plains toad	*Anaxyrus cognatus*	BLMS	K		Streams, floodplains

Table 3.13-13 Special Status Aquatic Species Occurring in Streams Crossed by the Transmission Systems

Common Name	Scientific Name	Status[1]	WTS	STS	Streams
Northern leopard frog	*Lithobates pipiens*	BLMS, FS, NESL G2	K		Paria River
Western (boreal) toad	*Anaxyrus boreas*	BLMS	K		Wetlands, floodplain (breeding period)
Invertebrates					
Desert springsnail	*Pyrgulopsis deserta*	BLMS	K		Virgin River
Niobrara ambersnail	*Oxyloma haydeni haydeni*	BLMS	K		Gypsum Wash

[1] Status: FE = Federally Endangered; FT = Federally Threatened; FPT = Federally Proposed Threatened; EXP/NE = Experimental/Non-essential population; BLMS = BLM Sensitive; FS = Forest Sensitive; NESL = Navajo Endangered Species List (G2 and G3); NV-P = Nevada Protected; CA = Conservation Agreement species.

[2] CH = Designated Critical Habitat; K = known occurrence.

3.13.3.3.1 Federally Listed, Candidate, and Proposed Aquatic Species

Colorado pikeminnow and razorback sucker are described above in Section 3.13.3.1.

3.13.3.3.1.1 Desert Pupfish

<u>Species Occurrence</u>

Desert pupfish were once common in the lower Gila and Colorado River drainages in Arizona, California, and Mexico. They also formerly occurred in reaches of some large rivers including the Colorado, Gila, San Pedro, and Santa Cruz rivers (Federal Register 49(96): 20740). As of 2010, naturally occurring populations of desert pupfish were limited to two tributaries and shoreline pools and irrigation drains of the Salton Sea in California. Although numerous reintroductions have been attempted, approximately 16 transplanted populations of the desert pupfish exist in the wild at present, all in Arizona (Tier 2 populations in the Recovery Plan) (USFWS 2010). There is a total of 47 captive or refuge desert pupfish populations (that do not qualify for the Tier 3 category), which include 34 sites in Arizona. Potential occurrence for desert pupfish is listed in Maricopa and Yavapai counties, Arizona. Desert pupfish is known to occur within the Agua Fria River drainage; however, there are no extant populations present in the mainstem of the Agua Fria or the Verde River (Weedman 2016).The closest known occurrence is located approximately 0.5 mile from the STS ROW. Critical habitat has been designated for desert pupfish in Imperial County, California and Pima County, Arizona, but none is present within the STS study area.

<u>Life History and Habitat Association</u>

Desert pupfish occurs in a wide variety of habits including springs, cienagas, small streams, and the margins of larger waterbodies (USFWS 1993). Occurrence in most of these habitats was characterized as having shallow water, soft bottom substrates, and clear water clarity. The habitats also typically contain rooted or unattached vegetation. This species can tolerate high salinities, high water temperatures, and lower oxygen content compared to most other fish species. The spawning period for desert pupfish ranges from early spring into winter.

<u>Listing and Conservation Status</u>

Desert pupfish was proposed as federally endangered with critical habitat in 1984 (49 Federal Register 20739-20744). The final determination of endangered species status and critical habitat was made in 1986 (51 Federal Register 10842-10851). A recovery plan was prepared for desert pupfish in 1993 (USFWS 1993). The goal of the recovery plan is to describe actions necessary to eliminate threats to extant populations and successfully establish additional populations in secure habitats within the species' historical range. Once the actions are successfully completed and meet specific criteria, downlisting from federally endangered to threatened would be considered. Based on a recent 5-year review for the species, no change in the recovery status was recommended (USFWS 2010). The recovery status continues to be a high degree of threat and a high potential for recovery.

Factors Affecting Species

Although aerial photo interpretation indicates that aquatic habitat is largely intact in the portions of the Agua Fria River that are traversed and paralleled by the STS, the proximity of these areas to human development suggests that desert pupfish habitat in the action area may be affected by recreational activities, road use and maintenance, and environmental contaminants such as pesticides. The presence of harmful non-native species also may be a factor affecting desert pupfish and their habitat in these portions of the study area.

Ecological Risk

Ecological risk from existing emissions has not been evaluated for this species as the transmission line systems are located outside of the area affected by emissions from NGS and the proposed KMC.

3.13.3.3.1.2 Gila Chub

Species Occurrence

Small remnant populations of Gila chub are known to occur in the Verde River drainage, with the mainstem portion of the Verde River being crossed by the STS ROW (USFWS 2008a). There currently are about 25 populations in tributaries of seven drainages in Arizona. This species has been eliminated from approximately 85 to 90 percent of its formerly occupied habitat, and much of the loss is unrecoverable. Population numbers in the Verde River are unknown. The trend over the past 10 years or three generations indicates that this species is expected to be slowly declining (NatureServe 2013d). The closest current population in the Verde River drainage is located in a tributary located approximately 20 miles east of the STS ROW. The Verde River would be considered potential habitat for Gila chub. Habitat for Gila chub also occurs in the Agua Fria River, which is crossed by the STS. Critical habitat is located in the Agua Fria River drainage, with the closest segments located in Lousy Canyon and Larry Creek. These critical habitat segments are located northeast and upgradient from the STS ROW at distances of 0.9 and 2.4 miles, respectively. Critical habitat also is located in the Verde River drainage, but the closest segment is approximately 18 miles east of the STS ROW.

Life History and Habitat Association

Gila chub typically inhabit pools in creeks and small streams, cienegas, and artificial impoundments at elevations from approximately 2,000 to 5,550 feet (USFWS 2008a). Gila chub often use aquatic habitat that contains cover such riparian vegetation or boulders and submerged logs. Adult fish are associated with deep pools and eddies below areas with swift currents. Young-of-year fish inhabit shallow water among plants or debris, while juvenile fish use areas with higher velocities. Gila chub breeds in late spring to summer (USFWS 2015b).

Listing and Conservation Status

Gila chub was proposed for federally endangered listing in August 2002 (67 Federal Register 51948-51985). The final rule for endangered status and critical habitat designation was published in November 2005 (70 Federal Register 66664-66721). A 5-year review was initiated for Gila chub in February 2009 to ensure that the federal listing status was accurate or needed to be changed (74 Federal Register 6917-6919). A public review draft of a recovery plan for Gila chub was made available on October 27, 2015 (80 Federal Register 65793-65795). Critical habitat has been designated in the Agua Fria and Verde rivers, but they are outside of the STS study area.

Factors Affecting Species

The establishment of non-native fishes within the Gila River basin is a primary threat to the persistence of Gila chub. Secondary threats are habitat alteration, destruction, and fragmentation. The influence of factors affecting Gila chub likely varies by location, with relatively few factors affecting potential Gila chub habitat at the Verde River crossing and a greater number of factors affecting critical habitat at the Agua Fria River crossings, which are in closer proximity to human development and therefore at greater risk of direct and indirect impacts from recreation within riparian corridors; livestock grazing; road construction, use, and maintenance; and environmental contaminants.

Ecological Risk

Ecological risk from existing emissions has not been evaluated for this species as the transmission line systems are located outside of the area affected by emissions from NGS and the proposed KMC.

3.13.3.3.1.3 Gila Topminnow

Species Occurrence

Gila topminnow is endemic to the Gila River system of Arizona, New Mexico, and northern Sonora, Mexico (Nico et al. 2015). Eleven of the naturally occurring populations are in the Santa Cruz River system, while the other two are in the Gila River drainage (Weedman 1998). Gila topminnow has been stocked in several sites in Arizona within their native range, including a tributary to the Agua Fria River (Nico et al. 2015). The Agua Fria River is crossed by the STS ROW; however, Gila topminnow has never been documented in the mainstem of the river (Weedman 2016). Gila topminnow has been stocked outside of its native historic range in a number of locations in Arizona including Cochise, Gila, Graham, Pima, Pinal, Santa Cruz, and Yavapai counties (Nico et al. 2015). Maricopa and Yavapai counties are crossed by the STS ROW. No critical habitat has been designated for Gila topminnow.

Life History and Habitat Association

Gila topminnow prefers shallow, warm, relatively quiet waters in a wide range of aquatic habitats including ponds, cienegas, tanks, pools, springs, small streams, and the margins of larger streams (USFWS 2015c). Dense mats of algae and debris along the margins of the habitats usually are an important component for cover and foraging areas. Organic muds and detritus also are used for foraging. The breeding period for Gila topminnow is from January through August, with some populations capable of breeding throughout the year.

Listing and Conservation Status

Gila topminnow was listed as federally endangered in March 1967 (32 Federal Register 2007). A 5-year review was initiated in 2007. A revised recovery plan was prepared for Gila topminnow in 1998 (Weedman 1998). The short-term goal of the plan is to prevent extirpation of the species from its natural locations in the U.S. and reintroduce it into suitable habitat within its former range.

Factors Affecting Species

Factors affecting Gila topminnow and its habitat within the study area are the same as listed for Gila chub. Potential habitat in the portions of the Agua Fria River that are traversed by the STS, is in close enough proximity to development that it is likely subject to some level of direct and indirect impacts associated with recreation within riparian corridors; livestock grazing; road construction, use, and maintenance; and environmental contaminants such as pesticides, as well as potential fuel and oil spills from cars and recreational vehicles.

Ecological Risk

Ecological risk from existing emissions has not been evaluated for this species as the transmission line systems are located outside of the area affected by emissions from NGS and the proposed KMC.

3.13.3.3.1.4 Loach Minnow

Species Occurrence

Historical records of loach minnow exist for the Verde River, but no current populations exist for this species (USFWS 2012c, 1990a). However, the species is considered to be extirpated from the Verde River. Due to declining populations of loach minnow, AGFD and the USFWS, in coordination with other agencies, established refuge populations and breeding stock at the AGFD Aquatic Research and Conservation Center. Since 2007, these agencies have stocked loach minnow in streams within their historic range. Critical habitat for loach minnow has been designated for the Verde River, which is crossed by the STS ROW.

Life History and Habitat Association

Loach minnow is a bottom-dwelling fish that occurs in small to large perennial creeks and rivers (USFWS 2012b). Habitat consists of shallow depths in turbulent riffles over cobble-dominated substrates up to elevations of approximately 8,000 feet. Some habitat used by this species contains dense filamentous growth (USFWS 1990a). Loach minnow spawn as 1-year-old fish in the winter through early spring (USFWS 1990a). The same riffles occupied by adults in the non-spawning period are used.

Listing and Conservation Status

The loach minnow was listed as a threatened species without critical habitat in 1986 (51 Federal Register 39468). Loach minnow was proposed for federal endangered status and critical habitat in October 2011 (75 Federal Register 66482-66552). The final rule for endangered status and critical habitat designation was made in February 2012 (77 Federal Register 10810-10932). The latest 5-year status review for this species was initiated in 2012. A recovery plan was prepared for the loach minnow in 1991 (USFWS 1990a). The recovery objective is to protect existing populations, restore populations in portions of historic habitat, and eventual delisting, if possible.

Factors Affecting Species

Threats to loach minnow include dams, water diversions, watershed degradation, channel modifications, and introduction of non-native fish species. Although flows in the reach of the Verde River that is crossed by the STS are likely controlled to some extent by Sullivan Dam, aerial photo interpretation indicates that aquatic and riparian habitats are intact in the action area with little or no evidence of watershed degradation and channel modification.

Ecological Risk

Ecological risk from existing emissions has not been evaluated for this species as the transmission line systems are located outside of the area affected by emissions from NGS and the proposed KMC.

3.13.3.3.1.5 Roundtail Chub

Species Occurrence

The Lower Colorado River distinct population segment of the roundtail chub is proposed for threatened status in Arizona and New Mexico. The current roundtail chub distinct population segments are found in five separate drainages that are isolated from one another (Little Colorado River, Bill Williams River, Gila River, Salt River, and Verde River).

Life History and Habitat Association

The roundtail chub occurs in cool to warm water over a wide range of rivers and streams throughout the Colorado River basin. The species typically occurs in open areas of the deepest pools and eddies of mid-sized to large rivers (USFWS 2009).

Listing and Conservation Status

On December 30, 1982 (47 Federal Register 58455), the roundtail chub was placed on a list of candidate species as a category 2 species. Roundtail chub retained this category candidate status until the practice identifying category 2 candidates was discontinued in 1996. In 1996, roundtail chub was removed from the candidate list. On April 14, 2003, the USFWS received a petition from the Center for Biological Diversity to list a distinct population segment of the roundtail chub in the Lower Colorado River Basin. A 90-day finding was published on July 12, 2005 (70 Federal Register 39981), which indicated that the petition presented substantial scientific information to warrant consideration for listing. Subsequent 12-month findings were published in May 2006 and July 2009 (71 Federal Register 26007 and 74 Federal Register 32352, respectively) regarding the definition of distinct population segment and whether the roundtail chub met the definition. The 2009 finding indicated that the population satisfied the discreteness and significance elements of the Interagency Policy Regarding the Recognition of Distinct Vertebrate Population Segments and qualified as a distinct population segment. From 2009 through 2014, the USFWS concluded that the listing of the lower Colorado River distinct population segment was warranted but precluded due to higher priority listing actions. The distinct population segment of the roundtail chub was proposed for federal threatened status on October 7, 2015 (80 Federal Register 60753-60783).

Currently, roundtail chub occupy approximately 43 percent of their historic range (80 Federal Register 60753-60783). The risk of extirpation in the Verde River is considered to be moderate. Past conservation efforts include the establishment of new populations for roundtail chub in the Lower Colorado Basin distinct population segment and the renovation or securing of currently occupied areas. There are currently four newly established sites for this species, with two being in the Verde River drainage (Gap and Roundtree creeks). There is a statewide conservation agreement for roundtail chub.

Factors Affecting Species

The primary factor affecting habitat for the roundtail chub within the action area is likely the presence of non-native fish species, which may compete with and prey upon the roundtail chub.

Ecological Risk

Ecological risk from existing emissions has not been evaluated for this species as the transmission line systems are located outside of the area affected by emissions from NGS and the proposed KMC.

3.13.3.3.1.6 Spikedace

Species Occurrence

Historically, spikedace was common throughout much of the Gila River drainage located north of Phoenix, Arizona, including the Verde River, which is crossed by the STS ROW (USFWS 2012d). By 2009, spikedace had not been collected in the Verde River in a decade (AGFD 2013b). Due to declining populations of spikedace, AGFD and the USFWS, in coordination with other agencies, established refuge populations and breeding stock at the AGFD Aquatic Research and Conservation Center. Since 2007, these agencies have stocked spikedace in streams within their historic range. Critical habitat for spikedace has been designated in the Verde River, which is crossed by the STS ROW.

Life History and Habitat Association

Spikedace occur in moderate to large perennial streams with moderate to high velocities and depths, usually less than about 3 feet (USFWS 2012d, 1990b). Adult fish often concentrate along gravel-sand bars; quiet eddies on the downstream edge of eddies; or broad, shallow areas above gravel-sand bars (USFWS 1990b). Recurrent flooding helps the spikedace maintain its competitive edge over invasion from exotic species in a stream (USFWS 2012d). Fish tend to use areas with higher flows in the springtime. Spikedace spawn in the spring (April through June) in response to a combination of stream discharge and water temperature (USFWS 1990b). Spawning habitat consists of shallow areas that are dominated by sand substrate.

Listing and Conservation Status

The spikedace was listed as a threatened species with critical habitat in 1986 (51 Federal Register 23769). Spikedace was proposed for federal endangered status and critical habitat in October 2011 (75 Federal Register 66482-66552). The final rule for endangered status and critical habitat designation was made in February 2012 (77 Federal Register 10810-10932). The latest 5-year status review for this species was in 2012. A recovery plan was prepared for the spikedace in 1991 (USFWS 1990b). The recovery objective is to protect existing populations, restore populations in portions of historic habitat, and eventual delisting, if criteria are met.

Factors Affecting Species

The primary factors affecting potential habitat for the spikedace within the study area are the presence of non-native fish species and groundwater pumping. Although flows in the reach of the Verde River that is crossed by the STS are likely controlled to some extent by Sullivan Dam, aerial photo interpretation indicates that aquatic and riparian habitats are intact in this portion of the action area with little or no evidence of watershed degradation and channel modification.

Ecological Risk

Ecological risk from existing emissions has not been evaluated for this species as the transmission line systems are located outside of the area affected by emissions from NGS and the proposed KMC.

3.13.3.3.1.7 Virgin River Chub

Species Occurrence

The Virgin River chub occurs in the Muddy and Virgin rivers, which are crossed by the WTS ROW. Virgin River chub is endemic to the Virgin River system in southwestern Utah, southern Nevada, and northwestern Arizona, and the Muddy (Moapa) River in Nevada. The current range for this species includes the Muddy River and the Virgin River near the Nevada-Arizona border to the southwestern corner of Utah. Although critical habitat has been designated for this species in the Virgin River, the Muddy River is not considered to be part of the federal listing or critical habitat designation at this time.

Life History and Habitat Association

Adult and juvenile Virgin River chub prefer deep runs and pools with slow to moderate velocities containing boulders or instream cover over sand or gravel substrate (65 Federal Register 4141; USFWS 2012e, 1994). Generally, larger fish occur in deeper portions of the stream. The species is very tolerant of high salinity and turbidity. Virgin River chub spawns during late spring and early summer over gravel and rock substrates.

Listing and Conservation Status

The Virgin River chub was officially listed as federally endangered in 1989, but designation of critical habitat was postponed (54 Federal Register 35305). In 2000, 87.5 miles of the Virgin River in Utah, Arizona, and Nevada was designated as critical habitat (65 Federal Register 4140). When the species was listed, the USFWS recognized that a closely related species was found in the Moapa (Muddy) River in Nevada, but it was affected by the listing in 1989. The Muddy River population is not considered part of the federal listing at this time. However, a proposed rule change regarding federal listing is under review by the USFWS.

The Virgin River Fishes Recovery Plan was prepared in 1994, which included Virgin River chub as one of the species that was addressed (USFWS 1994). The objective of recovery for Virgin River chub and woundfin for downlisting from federally endangered to threatened status. This recovery objective is based on the following criteria: 1) the Virgin River flows essential to survival of all life stages are protected; 2) degraded habitat in the Virgin River from Pah Tempe Springs to Lake Mead is upgraded; and 3) barriers are established to limit movement of non-native fish species and red shiner is eliminated from the Virgin River.

Factors Affecting Species

Threats to Virgin River chub include alteration of flows due to dam construction and water diversions, water quality degradation, and the introduction of non-native fish species.

Ecological Risk

Ecological risk from existing emissions has not been evaluated for this species as the transmission line systems are located outside of the area affected by emissions from NGS and the proposed KMC.

3.13.3.3.1.8 Woundfin

Species Occurrence

Historically, the woundfin occupied most of the lower Colorado River and Gila River basins in Arizona, Nevada, and Utah. Over the past 30 years, woundfin generally have declined throughout their occupied range (NatureServe 2013e). Except for the mainstem portion of the Virgin River, woundfin are extirpated from most of its historical range. Current distribution for woundfin extends from Pah Tempe (also called La Verkin Springs) on the mainstem of the Virgin River to Halfway Wash, Nevada (65 Federal Register 4141). Although the species was collected in the middle portion of the Muddy (Moapa) River in the 1960s, no additional specimens have been collected in the last 50 years. Critical habitat has been designated for woundfin, which includes portions of the Virgin River and its associated 100-year floodplain. The Virgin River is crossed by the WTS ROW.

Life History and Habitat Association

Woundfin adults and juveniles are most often collected from runs and quiet waters with adjacent riffles (65 Federal Register 4141; USFWS 2008b). Juvenile fish tend to be associated with habitats that contain slower and quieter water compared to adults. Larvae are found in backwater areas and stream margins. Spawning occurs during late spring when flows are declining (65 Federal Register 4141).

Listing and Conservation Status

Woundfin was listed as federally endangered in October 1970 for its entire range of occurrence in Arizona and New Mexico except the Gila River (35 Federal Register 16047-16048). Critical habitat was designated for woundfin in January 2000 (65 Federal Register 4140-4156). The most recent 5-year review for woundfin was completed in April 2006 (71 Federal Register 54922-54923). The original recovery plan for woundfin was prepared in 1979 and revised in 1985. The Virgin River Fishes Recovery Plan was prepared in 1994, which included woundfin as one of the species that was addressed (USFWS 1994). The objective and criteria of recovery for woundfin are the same as described for Virgin River chub. The Virgin River Habitat Conservation and Recovery Program was completed in July 2007 (72 Federal Register 54922-54923).

Factors Affecting Species

Threats to woundfin include alteration of flows due to dam construction and water diversions, water quality degradation, and the introduction of non-native fish species.

Ecological Risk

Ecological risk from existing emissions has not been evaluated for this species as the transmission line systems are located outside of the area affected by emissions from NGS and the proposed KMC.

3.13.4 Environmental Consequences

3.13.4.1 Issues

3.13.4.1.1 Navajo Generating Station

Issue 1 – Emissions and Deposition - special status aquatic species within the NGS Near-field, Gap Regions, and the San Juan River ERA areas were analyzed for emission and deposition effects. Critical habitat for federally listed fish species in the Gap Regions and the San Juan River ERA areas were analyzed for emission and deposition effects.

3.13.4.1.2 Proposed Kayenta Mine Complex

Issue 1 – Emissions and Deposition - potential impacts of emission and deposition caused by KMC future operations were analyzed for effects on northern leopard frog.

Issue 2 – Groundwater Pumping - mine well pumping was modeled to determine potential effects on groundwater and connected surface waters, ultimately affecting northern leopard frog.

3.13.4.1.3 Transmission Systems and Communication Sites

Issue 1 – Operation and Maintenance - effects of operation and maintenance of the transmission systems were analyzed for special status aquatic species in perennial streams crossed by the WTS and STS ROWs.

3.13.4.2 Assumptions and Impact Methodology

3.13.4.2.1 Assumptions

The following assumptions were used in the impact analysis for special status aquatic species.

- Known or recent records of special status species occurrences within portions of the study area were considered to represent "presence."
- Surrogate species identified in the ERAs are representative of special status fish species that occur in the study area. Surrogate species that were used for federally listed fish species are mentioned in the impact discussions.
- Assumptions used in the emission and deposition analyses are described in the ERAs (Ramboll Environ 2016a,b,c,d).
- Potential surface disturbance from operation and maintenance activities could occur within the WTS and STS ROWs. However, there would be no direct disturbance within the stream perennial stream channels by vehicles or equipment.

3.13.4.2.2 Impact Methodology

The impact methodologies used to analyze project effects on special status aquatic species are the same as those listed in Section 3.12.3, Aquatic Biological Resources. Impacts are organized by each of the federally listed species followed by a combined section for other special status species with BLM, U.S. Forest Service, Navajo Nation, Hopi Tribe, or state designations. Impact discussions are organized by federally listed species so that the information tracks with the Biological Assessment. A summary of the methodologies for the ERAs is provided in **Appendix 3RA**, Ecological and Human Health Risk Assessments and full detail is provided in the ERA reports (Ramboll Environ 2016a,b,c,d).

Fish species for which mercury concentration data were available were used as surrogate species as being representative of the fish species of interest in the ERAs. Special status species fish include humpback chub, bonytail chub, razorback sucker and Colorado pikeminnow.

Impacts are discussed for all project components. However, due to a lack of perennial aquatic habitat along the BM&LP Railroad ROW, no special status species occur in this study area. As a result, there would be no impacts from the railroad operation on special status aquatic species and no further analysis was conducted for the BM&LP Railroad ROW.

Impact parameters and toxicity thresholds were used in combination with effects information for the purpose of estimating the intensity of impacts to special status aquatic species. The impact parameters vary depending on the project component, as listed below. Threshold values were not used for the transmission systems because the nature of the impacts from operation and maintenance activities would not involve direct disturbances to perennial stream habitat.

- NGS Deposition Risks to Special Status Aquatic Species – Both maximum and refined HQ values resulting from the ERAs (Ramboll Environ 2016a,b,c,d) were used as indicators of risk to special status aquatic species from metals (mainly arsenic, mercury, and selenium). Maximum HQs were used in the analysis as a conservative estimate of the highest exposure level for individual species. The environmental consequences section focused on the refined HQs, since they are considered to be a realistic estimate of exposure. Refined HQ values of 1 or greater were indicators of potential risk to aquatic species. Refined HQs less than 1 were considered to represent negligible risk to aquatic species. The effect thresholds for special status fish were based on literature-derived CBRs including 0.2 mg/kg wet weight for mercury (Dillon et al. 2010); 2 mg/kg wet weight for selenium (USEPA 2016); and 1 mg/kg wet weight for arsenic (McGeachy and Dixon 1990). Additional detail on this analysis is provided in Section 3.0.3 of this EIS and in the ERA reports.

- NGS Deposition Effects on Critical Habitat for Federally listed Fish Species – The effect on critical habitat was analyzed in the San Juan River and Gap Region (Colorado River) for federally listed fish species. Impact parameters used for the critical habitat analysis are described in further detail below.
- Injury Effects to Federally Listed Fish Species – The effect on federally listed fish species was estimated using the USFWS methodology and expressed as the number of individuals affected for various life stages. The impact methodology used for the injury effects analysis is described in further detail below.
- Proposed KMC Groundwater Pumping – The percent change in stream flows compared to baseline conditions was used as an indicator of effects on the special status species, northern leopard frog.
- Transmission Systems – Perennial streams crossed by the WTS and STS ROW and access road system were used as an indicator of areas where potential operation and maintenance activities needed to be assessed.

3.13.4.2.2.1 Injury Effect Quantification for Federally Listed Fish Species

Quantification of injury effects on individual fish was made for two federally listed species in the San Juan River (Colorado pikeminnow and razorback sucker) and Southwest Gap Region (humpback chub and razorback sucker). The injury effect analyses were conducted by the USFWS. Results are considered to be preliminary at this time. Based on magnitude of impacts, evaluation of the best available science, and discussions with USFWS during informal consultation, the preliminary estimates are considered to be a reasonable estimate of anticipated impacts to the fish species. Injury effects will be finalized in the Biological Opinion for this project. Additional details on the methodology for the quantification analysis are provided in **Appendix 3.13-A** of this EIS. A summary of the Southwest Gap Region and San Juan River analyses are described below.

The effect quantification for the federally listed fish species was a separate analysis that provided an estimate of the number of individuals by life stage that could be affected by project emissions and deposition. The effect analysis also provides a separate line of evidence as to whether the listed fish would be affected by the project, and it is distinct from what was conducted for the ERAs, which identified potential risk of effects to species. The ERA results were used in determining whether an injury effect analysis should be completed. The ERAs do not quantify the effect on individuals. Both analyses used some of the same toxicity information such as threshold effect levels for mercury and selenium. However, the effect quantification applied toxicity information to population and life stage numbers to provide an estimate of the number of individuals affected.

- Southwest Gap Region – The injury estimate for the Southwest Gap Region was done using population data for humpback chub and the recovery population number for razorback sucker (5,600 adults). Toxicity dose-response curves for the various life stages of these species (eggs/embryos, larvae, juveniles, and adults) were applied to the population estimates for adults. The total number of individuals injured was estimated for the entire period of 2020 to 2074. The estimate was for the total combination of baseline, project emissions, and other cumulative emission sources.
- San Juan River – The injury estimate for the San Juan River was done using (1) population data for Colorado pikeminnow and razorback sucker in combination with (2) mercury toxicity dose-response curves for the various life stages of the species (eggs/embryos, larvae, juveniles, and adults) and (3) estimated total cumulative dose from baseline, NGS emissions and other cumulative sources. Injury was estimated for subadults (juveniles) and adults based on effects most likely to impact individuals including reproduction, survival, and growth. Behavior also was considered. Injury was expressed as the number of individuals affected. The total number of individuals potentially injured was estimated for the entire period of 2020 to 2074. The estimate

was for the total combination of baseline, project emissions, and other cumulative emission sources.

Species effects also were evaluated in terms overall population numbers to determine the context of the impact. This consideration of impact context was then used to determine the relative magnitude of the impact. Impacts to special status aquatic species were evaluated in terms of four categories: none, negligible, minor, or moderate. These categories are defined in Section 3.0 of this EIS. There were no major effects on special status aquatic species, as defined in Section 3.0. The categories used for the various effects are further explained in the species discussions.

3.13.4.2.2.2 Critical Habitat Analysis

The critical habitat analysis was conducted following direction from the USFWS to evaluate potential impacts to critical habitat in the San Juan River and Colorado River Gap Regions (Northeast Gap and Southwest Gap). The ERA evaluated potential for adverse effects to the aquatic community by comparison of surface water concentrations to applicable water quality standards and evaluated fish by comparison of fish tissue concentrations to protective tissue concentrations. The outcomes of those evaluations serve as a point of departure to evaluate potential effects on the water element of critical habitat. Per USFWS direction, critical habitat was conservatively analyzed in the San Juan River, Northeast Gap Region (Colorado River above Lake Powell), and Southwest Gap Region (lower Colorado River), because maximum and refined tissue-based total cumulative HQs were1 or greater for all four listed fish species (bonytail chub, Colorado pikeminnow, humpback chub and razorback sucker) in the Northeast Gap Region (Colorado River above Lake Powell), humpback chub and razorback sucker in the Southwest Gap Region (Colorado River below Lake Powell), and Colorado pikeminnow and razorback sucker in the San Juan River.

The deposition effects on critical habitat for federally listed fish species was analyzed using two primary methods for assessing potential effects. Evaluation was based on comparison of measured surface water concentrations to: 1) applicable state and/or federal water quality criteria; and/or 2) species specific protective surface water concentration developed by the USFWS. The latter comparison was performed by establishing a protective water concentration for methylmercury, for which adequate species data and dose-response data are available. For evaluation of arsenic and selenium, comparison was done by comparing dissolved (filtered) surface water concentrations for arsenic and selenium to applicable chronic ambient water quality criteria as listed in the USEPA National Ambient Water Quality Criteria (National Ambient Water Quality Criteria [USEPA 2009, 2016]), which are 3.1 µg/L for selenium (based on recent finalization of the criteria by USEPA) and 150 µg/L for arsenic. For mercury, the National Ambient Water Quality Criteria is 0.77 µg/L (dissolved), which is inclusive of inorganic and organic mercuric compounds, was considered in addition to the protective methylmercury level developed by USFWS; a National Ambient Water Quality Criterion for methylmercury is not available. State-specific and/or Navajo Nation Water Quality Standards are also considered, as applicable, to assess critical habitat effects. Because tissue-based HQs and comparison of surface water concentrations resulted in no exceedance of applicable ecological screening values for arsenic, arsenic exposure to special status species is negligible.

The USFWS methylmercury surface water concentration protective of piscivorous fish was estimated as 0.0002 µg/L based on back-calculation of a protective water concentration using the no observed effect concentration CBR of 0.2 milligrams per kilogram, wet weight (mg/kg ww) per Beckvar et al. (2005) and the bioconcentration factor of 1,300,000 based on literature-derived surface and fish tissue concentrations for predatory fish in the NGS Near-field study area, that includes Lake Powell and Colorado River water data and fish tissue data (Ramboll Environ 2016a). Per USFWS methodology, a conclusion of an “effect” on critical habitat was made if surface water concentrations exceeded the respective criterion or species-specific protective water concentration.

3.13.4.2.2.3 Conservation Measures

Conservation measures are described in the impact discussions for Colorado pikeminnow, humpback chub, and razorback sucker to mitigate the effects of NGS emissions and deposition of mercury and selenium in the Southwest Gap Region (Colorado River downstream of Glen Canyon Dam) and San Juan River. The conservation measures also are described in **Appendix 4A** of this EIS. Mitigation for special status fish species that occur in the transmission system ROWs and road systems would be implemented as best management practices in combination with several additional measures to protect critical habitat for Gila topminnow, loach minnow, spikedace, Virgin River chub, and woundfin.

A monitoring measure also would be implemented to address data uncertainty and evaluate the effectiveness of water quality and tissue sampling or reporting of ongoing efforts of the proposed fish conservation measures for the purpose of assuring that air modeling assumptions and ERA results were within the range analyzed in the EIS and Biological Assessment, and that conservation measures implementation are effective. The monitoring measure is described in **Appendix 4A** of this EIS.

3.13.4.3 Proposed Action

The following information describes impacts of the Proposed Action on special status species. The section is organized by federally listed species followed by other special status aquatic species. Organization by federally listed species is parallel with the structure of the Biological Assessment. The overall goal is to ensure that the EIS process and the USFWS Section 7 consultation are consistent to the extent possible. Within each species section, impacts are discussed for the project components relevant to the species. An overall summary of Proposed Action impacts are provided at the end of the section. The discussion of impacts first describes effects from the various project components followed by the Proposed Action effects in combination with baseline fish tissue concentrations. Applicant-committed protection measures and best management practices are discussed as part of the impact discussions.

3.13.4.3.1 Navajo Generating Station

3.13.4.3.1.1 Federally Listed Aquatic Species

<u>Bonytail</u>

The impact issue analyzed for bonytail is the potential effect of NGS emissions on the species and its critical habitat. Bonytail and its critical habitat were analyzed for the Northeast Gap Region.

<u>*Northeast Gap Region*</u>

The NGS 3-Unit Operation and 2-Unit Operation would represent a negligible risk to bonytail tissue from mercury, as indicated by refined HQs of 0.002 and 0.001, respectively (**Table 3.13-14**). Tissue concentrations also would be considerably below the threshold level of 0.2 mg/kg wet weight. The addition of NGS emissions with baseline conditions would result in a negligible risk from mercury, as the refined HQ was less than 1 (i.e., the tissue concentration was less than the tissue threshold). Measured arsenic and selenium concentrations in fish tissue were not available for the Northeast Gap Region; therefore, surface water concentrations were used in modeling uptake into fish tissue. The refined HQ for the modeled 3-Unit Operation and 2-Unit Operation for the bonytail surrogate was 5 orders of magnitude below an HQ of 1 for selenium and arsenic, respectively, indicating a negligible risk to bonytail in the Northeast Gap Region. The project contribution to the total effect of the project and baseline fish tissue would be less than 1 percent.

Table 3.13-14 Mercury and Selenium Tissue Concentrations for Bonytail Surrogate (Rainbow Trout) in the Northeast Gap Region

Metal	CBR (mg/kg wet weight)	Baseline [1]		3-Unit Operation		2-Unit Operation		3-Unit	2-Unit
		Conc. (mg/kg wet weight)	HQ	Conc. (mg/kg wet weight)	HQ	Conc. (mg/kg wet weight)	HQ	Contribution of Operation [2] (%)	
Mercury									
Maximum	0.2	0.12	0.6	0.0006	0.003	0.0004	0.002	0.5%	0.3%
Refined	0.2	0.09	0.5	0.0003	0.002	0.0002	0.001	0.3%	0.2%
Selenium									
Maximum	2	*0.84*	0.4	0.0001	0.00005	0.00007	0.00004	0.01%	0.01%
Refined	2	*0.33*	0.2	0.00007	0.00003	0.00005	0.00002	0.02%	0.01%

[1] Baseline values presented in italicized text indicate measured tissue data not available; concentration based on modeled result using site-specific uptake factor and surface water concentration.

[2] Contribution of operation is the contribution of 3-Unit Operation and 2-Unit Operation to the Proposed Action (the sum of baseline and NGS operations).

CBR = critical body residue.

Critical habitat is limited to the Upper Colorado River near the Green River confluence (Northeast Gap Region study area), more than 100 miles from the NGS plant. Project-related effects to critical habitat would be limited to those resulting from emissions and depositions from operation of the NGS plant. The effect of Proposed Action emissions on water quality and critical habitat in the Northeast Gap Region study area would be negligible. Based on the USFWS methodology described in Section 3.13.4.2, the analysis of the water element of critical habitat involved an evaluation of mercury and selenium concentrations. The maximum baseline concentration of mercury (0.24 µg/L, dissolved) in surface water in the Northeast Gap Region study area was less than the National Ambient Water Quality Criteria (0.77 µg/L), but it exceeded the conservative Utah Water Quality Standard (0.012 µg/L). The mean and refined concentrations (0.017 and 0.034 µg/L, respectively) also exceeded the Utah standard, with the refined concentration exceeding by 2.8-fold above the standard. However, the USFWS "back-calculated" a surface water concentration protective of fish from the CBR for methylmercury (0.2 mg/kg ww) using site-specific bioconcentration factors for predatory fish as indicated in Section 3.13.4.2 for comparison to water concentrations. Conservative bioconcentration factors for methylmercury were developed from literature-derived piscivorous fish tissue data and surface water concentrations as reported in Ramboll Environ (2016a) and were used to calculate the water concentrations corresponding to the CBR, protective of piscivorous fish species. The dissolved surface water methylmercury concentration protective of fish was estimated to be 0.0002 µg/L. Based on comparison of this value to the total (unfiltered) maximum methylmercury surface water concentration (0.00003 µg/L) and refined (0.000017 µg/L) baseline surface water concentrations (dissolved concentrations were not available) in the Northeast Gap Region study area no exceedance is noted. The maximum surface water concentration for methylmercury due to the Proposed Action is 0.00000013 µg/L and refined is 0.00000007 µg/L, which are well below the protective CBR-based concentration alone or in combination with the Proposed Action; NGS contributes as much as 0.8% to the methylmercury surface water concentration assuming maximum (3-Unit) operation.

For selenium, the maximum concentration in the Northeast Gap Region study area of 5.1 µg/L (total) was in excess of the Utah water quality standard. The Utah selenium standard is expressed as a dissolved (filtered) value (4.6 µg/L) and comparison to the maximum dissolved concentration for selenium (6.5 µg/L results in a minimal exceedance of 1.4-fold above the standard. However, both the refined concentration (95% upper concentration limit) and average concentration were less than the water quality standard.

For both mercury and selenium, based on Proposed Action (maximum) deposition concentrations, the project contribution results in a very small addition to the baseline concentration (less than 0.8 percent) and does not substantively affect the baseline condition. Therefore, the Proposed Action would represent a negligible effect on the water element of critical habitat for bonytail in the Northeast Gap Region study area.

No applicant-committed protection measures or additional mitigation would be required for the bonytail, because there is negligible risk to the species in the Northeast Gap Region. NGS emissions and baseline conditions would result in a negligible effect to bonytail.

Colorado Pikeminnow

The impact issue analyzed for Colorado pikeminnow was the potential effect of NGS emissions to Colorado pikeminnow in the Northeast Gap Region and the San Juan River. Largemouth bass was the surrogate species for Colorado pikeminnow in the Northeast Gap Region ERA, while striped bass represented the species in the San Juan River ERA (Ramboll Environ 2016b,c). The rationale for using surrogate species was to use species that are representative of Colorado pikeminnow in terms of diet and feeding strategy, as well as fish that are exposed to similar environmental/habitat conditions. Mercury and selenium tissue data for Colorado pikeminnow also were used in the analysis for this species, but the samples used were from stocked fish. Critical habitat is located in both of these areas. Results from these study areas are summarized below. The primary constituent elements for Colorado pikeminnow critical habitat also were analyzed using mercury and selenium concentrations for the water element and ERA results for forage fish as part of the biological environment element using the USFWS methodology. Because the Near-field ERA study area does not extend to the arms of the lake, Colorado pikeminnow use of Lake Powell was analyzed in the Northeast Gap Region and San Juan River ERA study areas.

Northeast Gap Region

The effect of the NGS emissions on Colorado pikeminnow would be the same as discussed for bonytail (**Table 3.13-15**). There would be a negligible risk to Colorado pikeminnow from either the 3-Unit Operation or 2-Unit Operation from mercury, as indicated by refined HQs of 0.002 and 0.001, respectively. Tissue values also would be considerably less than the tissue threshold of 0.2 mg/kg wet weight. The addition of NGS emissions with baseline conditions would result in a negligible risk from mercury, as the refined HQ was less than 1 and the tissue concentration was less than the tissue impact threshold. Refined tissue-based HQs for selenium and arsenic also were considerably less than 1, which indicates a negligible risk of NGS emissions on Colorado pikeminnow. Based on these results for the NGS Proposed Action, a negligible effect is expected for Colorado pikeminnow in the Northeast Gap Region. There would be no injury or loss of individual fish from arsenic, mercury, and selenium exposure in this study area. The project contribution would be less than 1 percent of the total effect from the project and baseline fish tissue concentrations.

Table 3.13-15 Mercury and Selenium Tissue Concentrations for Colorado Pikeminnow Surrogate (Largemouth Bass) in the Northeast Gap Region

		Baseline [1]		3-Unit Operation		2-Unit Operation		3-Unit	2-Unit
Metal	CBR (mg/kg wet weight)	Conc. (mg/kg wet weight)	HQ	Conc. (mg/kg wet weight)	HQ	Conc. (mg/kg wet weight)	HQ	Contribution of Operation [2] (%)	
Mercury									
Maximum	0.2	0.12	0.6	0.00058	0.003	0.00039	0.002	0.50%	0.33%
Refined	0.2	0.12	0.6	0.00031	0.002	0.00021	0.001	0.0.3%	0.2%
Selenium									
Maximum	2	*0.84*	0.4	0.00011	0.00005	0.00007	0.00004	0.01%	0.01%
Refined	2	*0.33*	0.2	0.000068	0.00003	0.00005	0.00002	0.02%	0.01%

[1] Baseline values presented in italicized text indicate measured tissue data not available; concentration based on modeled result using site-specific uptake factor and surface water concentration.

[2] Contribution of operation is the contribution of 3-Unit Operation and 2-Unit Operation to the Proposed Action (the sum of baseline and NGS operations).

CBR = critical body residue.

The critical habitat analysis for Colorado pikeminnow in the Northeast Gap Region related Project effects to the principal constituent elements (water, physical habitat, and biological environment). The Proposed Action would not affect the physical habitat component of critical habitat, because there is no direct disturbance or alteration of the river flow or substrate. There would be no effect on the biological environment, because the ERA results indicated HQs less than 1 for all fish and other aquatic community receptors that may be potential food sources of Colorado pikeminnow.

Based on the USFWS methodology described in Section 3.13.4.2, the analysis of the water element of critical habitat involved an evaluation of mercury and selenium concentrations in relation to the National Ambient Water Quality Criteria and Utah water quality standards. The evaluation of mercury and selenium is the same as discussed for bonytail. For both mercury and selenium, based on 3-Unit Operation (maximum) deposition concentrations, the project contribution results in a very small addition to the baseline concentration (less than 0.8 percent) and does not substantively affect the baseline condition. Therefore, the Proposed Action would represent a negligible effect on the water element of critical habitat in the Northeast Gap Region.

San Juan River

ERA analyses for Colorado pikeminnow in the San Juan River were completed for a surrogate species (striped bass) (**Table 3.13-16**) and pikeminnow tissue data (**Table 3.13-17**) (Ramboll Environ 2016c). Both the surrogate and Colorado pikeminnow results for the Proposed Action showed very low HQs, which indicate a negligible risk to the species. The combination of NGS emissions from the 3-Unit Operation and 2-Unit Operation with baseline surrogate fish tissue concentrations showed maximum HQs slightly greater than 0.07 for arsenic, 2 for mercury, and 0.7 for selenium (**Table 3.13-16**). Refined HQs were the same as the maximum values for arsenic and selenium, but the refined mercury HQ was 1. The HQ for mercury indicates a negligible potential risk to Colorado pikeminnow, arsenic and selenium. The combination of NGS emissions from the 3-Unit Operation and 2-Unit Operation with baseline conditions for the pikeminnow tissue analysis showed HQs that are slightly greater than 0.07 for arsenic, 0.5 for mercury, and 0.4 for selenium (**Table 3.13-17**). The pikeminnow tissue analysis indicated a negligible risk for all three metals, as indicated by HQs less than 1. The surrogate analysis results were considered to be a more conservative approach to estimate potential exposure because stocked fish reared in a hatchery in different water quality conditions and with different food base may not bioaccumulate at the same levels of mercury as wild Colorado pikeminnow. Both the species-specific and surrogate analyses indicated that the project contribution would be less than 1 percent of the total effect from the project and baseline fish tissue concentrations.

Table 3.13-16 Arsenic, Mercury, and Selenium Tissue Concentrations for Colorado Pikeminnow Surrogate (Striped Bass) in the San Juan River

Metal	CBR (mg/kg wet weight)	Baseline Conc. (mg/kg wet weight)	Baseline HQ	3-Unit Operation Conc. (mg/kg wet weight)	3-Unit Operation HQ	2-Unit Operation Conc. (mg/kg wet weight)	2-Unit Operation HQ	3-Unit Contribution of Operation [1] (%)	2-Unit Contribution of Operation [1] (%)
Arsenic[2]									
Maximum	5.5	0.37	0.07	0.00010	0.00002	<0.00010	<0.00002	0.03%	<0.03%
Refined	5.5	0.37	0.07	0.000086	0.00002	<0.000086	<0.00002	0.02%	<0.02%
Mercury[2]									
Maximum	0.2	0.49	2	0.00029	0.001	<0.00029	<0.001	0.06%	<0.06%
Refined	0.2	0.21	1	0.00018	0.0009	<0.00018	<0.0009	0.09%	<0.09%
Selenium									
Maximum	2	1.3	0.7	0.00026	0.0001	0.00018	0.00009	0.02%	0.01%
Refined	2	1.3	0.7	0.00024	0.0001	0.00016	0.00008	0.02%	0.02%

[1] Contribution of operation is the contribution of 3-Unit Operation and 2-Unit Operation to the Proposed Action (the sum of baseline and NGS operations).

[2] For the 2-Unit Operation, arsenic and mercury concentrations were less than the 3-Unit Operation but below the computational limit of the Electric Power Research Institute (2016) model, and so could not be calculated. Therefore, tissue concentrations from the 3-Unit Operation concentrations were conservatively used for the 2-Unit Operation.

CBR = critical body residue.

Table 3.13-17 Arsenic, Mercury, and Selenium Tissue Concentrations for Colorado Pikeminnow Tissue in the San Juan River

Metal	CBR (mg/kg wet weight)	Baseline[1] Conc. (mg/kg wet weight)	Baseline[1] HQ	3-Unit Operation Conc. (mg/kg wet weight)	3-Unit Operation HQ	2-Unit Operation Conc. (mg/kg wet weight)	2-Unit Operation HQ	3-Unit Contribution of Operation [2] (%)	2-Unit Contribution of Operation [2] (%)
Arsenic[3]									
Maximum	5.5	0.37	0.07	0.00010	0.00002	<0.0001	<0.00002	0.03%	<0.03%
Refined	5.5	0.37	0.07	0.000086	0.00002	<0.000086	<0.00002	0.02%	<0.02%
Mercury[3]									
Maximum	0.2	0.25	1	0.00029	0.0010	<0.00029	<0.0010	0.11%	<0.11%
Refined	0.2	0.11	0.5	0.00018	0.0008	<0.00018	<0.0008	0.16%	<0.16%

Table 3.13-17 Arsenic, Mercury, and Selenium Tissue Concentrations for Colorado Pikeminnow Tissue in the San Juan River

Metal	CBR (mg/kg wet weight)	Baseline[1] Conc. (mg/kg wet weight)	Baseline[1] HQ	3-Unit Operation Conc. (mg/kg wet weight)	3-Unit Operation HQ	2-Unit Operation Conc. (mg/kg wet weight)	2-Unit Operation HQ	3-Unit Contribution of Operation [2] (%)	2-Unit Contribution of Operation [2] (%)
Selenium									
Maximum	2	1.1	0.5	0.00026	0.0001	0.00018	0.00009	0.02%	0.02%
Refined	2	0.78	0.4	0.00024	0.0001	0.00016	0.00008	0.03%	0.02%

[1] Baseline tissue values presented for arsenic are for surrogate species (striped bass). Measured tissue concentrations not available for arsenic.

[2] Contribution of operation is the contribution of 3-Unit Operation and 2-Unit Operation to the Proposed Action (the sum of baseline and NGS operations).

[3] For the 2-Unit Operation, arsenic and mercury concentrations were less than the 3-Unit Operation but below the computational limit of the Electric Power Research Institute (2016) model and so could not be calculated. Therefore, tissue concentrations the 3-Unit Operation concentrations were conservatively used for the 2-Unit Operation.

CBR = critical body residue.

Based on population and toxicity data, the injury effects were estimated for Colorado pikeminnow in the San Juan River by the USFWS methodology, which is described in **Appendix 3.13-A**. The results are considered an initial estimate, which will be finalized as part of the Biological Opinion. The effect quantification for the federally listed fish species was a separate analysis that provided an estimate of the number of individuals by life stage that could be affected by project emissions and deposition. The effect analysis also provides a separate line of evidence as to whether the listed fish would be affected by the project, and it is distinct from what was conducted for the ERAs, which identified potential risk of effects to species. The ERA results were used in determining whether an injury effect analysis should be completed. The ERAs do not quantify the effect on individuals. Both analyses used some of the same toxicity information such as threshold effect levels for mercury and selenium. However, the effect quantification applied toxicity information to population and life stage numbers to provide an estimate of number of individuals affected. The analysis estimated that up to one adult or subadult would be injured by the NGS Proposed Action emissions (**Table 3.13-18**). The impact on Colorado pikeminnow is considered to be minor because less than 1 percent of the current Colorado pikeminnow (1,000 stocked fish less than 300 mm total length) would be affected by the Proposed Action emissions and deposition.

Table 3.13-18 Mercury Injury Effects to Colorado Pikeminnow in the San Juan River, 2020 to 2074

Metal	Life Stages[1] (number of individuals): Eggs/ Embryos	Larvae	Adult Reproduction	Juveniles (<400 mm)	Adults (>400 mm)	Subadult Behavioral Injury	Adult Behavioral Injury
Mercury	593	12	1	1	1	1	1

[1] Values less than 1 rounded to 1.

Critical Habitat Effects – To evaluate the effects of the Proposed Action on Colorado pikeminnow critical habitat, Project actions were related to the Principal Constituent Elements (water, physical habitat, and biological environment). The Proposed Action would not affect the physical habitat component of critical habitat, because there is no direct disturbance or alteration of the river flow or substrate. There could be a potential effect on the biological environment because the ERA analysis indicted a potential for risk (refined HQ exceeding 1) from selenium on one of the forage species (red shiner) that represents a food potential source for Colorado pikeminnow. However, it is important to note that the ERA analysis indicated negligible risk for other forage species such as bluehead sucker, flannelmouth sucker, and fathead minnow.

Based on the USFWS methodology described in Section 3.13.4.2, the effect of the Proposed Action on the water element of critical habitat for Colorado pikeminnow would represent a minor effect in the San Juan River. The minor effect was determined based on calculations performed by USFWS that "back-calculated" a surface water concentration protective of fish from the CBR for methylmercury (0.2 mg/kg ww) using site-specific bioconcentration factors as indicated in Section 3.13.4.2. Conservative bioconcentration factors for methylmercury were developed from literature-derived piscivorous fish tissue data and surface water concentrations as reported in Ramboll Environ (2016a) and were used to calculate the water concentrations corresponding to the CBR, protective of piscivorous fish species. The dissolved surface water methylmercury concentration protective of fish was estimated to be 0.0002 μg/L. Based on comparison of this value to the maximum (1.6 μg/L) and refined (0.21 μg/L) baseline surface water concentrations for mercury (total mercury, which accounts for methylmercury and inorganic mercury forms) in the San Juan River, exceedance is noted; the maximum surface water concentration for total mercury due to the Proposed Action is 0.0000008 μg/L and refined is 0.00000014 μg/L, well below the protective CBR-based concentration alone or in combination with the Proposed Action. NGS contributes less than 0.0001% to the methylmercury surface water concentration assuming maximum (3-Unit) operation.

For selenium, maximum surface water concentrations due to the Proposed Action (5 μg/L, unfiltered) exceeds the 2 μg/L Navajo Nation Water Quality Standard for total selenium (Navajo Nation Environmental Protection Agency 2004). The maximum dissolved (filtered) surface water due to the Proposed Action (12 μg/L) also exceeds the water quality criteria for lotic systems (3.1 μg/L, dissolved) per *USEPA Selenium Ambient Water Quality Criteria* (USEPA 2016). However, no exceedances for selenium are noted based on consideration of refined (95% upper concentration limit) or average surface water concentrations. Critical habitat would not be affected by selenium, because the baseline selenium concentrations plus the small contribution from NGS emissions (which would contribute up to about 0.2% to the refined total selenium concentration) does not exceed the National Ambient Water Quality Criteria Water Quality Standard or Navajo Nation Water Quality Standard.

Applicant-committed protection measures would be implemented to mitigate for the potential minor effect of the Proposed Action, and provide additional conservation and recovery benefits to the Colorado pikeminnow in the San Juan River. The Conservation Program and the conservation and monitoring measures for federally listed fish species are described in **Appendix 4A** of this EIS. Monitoring also would be implemented as part of the Proposed Action to evaluate the effectiveness of water quality and tissue sampling or reporting of ongoing efforts of the proposed conservation measures for the purpose of assuring that air modeling assumptions and ERA results are correct over time and that the conservation measures are effective. Monitoring would focus on mercury and selenium concentrations in the water column, sediment, and fish tissue in the San Juan River and Southwest Gap Region. Details of the monitoring measure are described in **Appendix 4A** of this EIS. The following measures are applicable to Colorado pikeminnow in the San Juan River or its overall population in the Upper Colorado River. Benefits to the species also are discussed for each measure.

FS-3: Support Activities at the USFWS Southwest Native Aquatics Research and Recovery Center (formerly known as the Dexter Fish Hatchery)

Goals: The objective of this measure is to provide financial support to Southwestern Native Aquatic Resources and Recovery Center (SNARRC) for the purpose of augmenting the genetic diversity of the four federally listed Colorado River fish species. Funding to support SNARRC's activities will be used to support research, propagation, and conservation activities for all of these species. This measure will offset Project-related impacts to razorback sucker, Colorado pikeminnow, and bonytail by improving the genetic diversity of the broodstock and numbers of these fish that will be available for stocking efforts in the San Juan River and potentially other areas to support the general species recovery.

<u>Conservation Need</u>: Effects from mercury deposition impact all life stages of fish, from larvae to adults. Effects range from reduced fecundity to disruption of various physiological processes. While the effects of mercury have been found to be more prevalent in fish species that feed at the top of the food chain, all species may be impacted from increased mercury loading. Increasing the number of fish in an aquatic system through rearing and stocking is one of the primary methods that is used to conserve and recover endangered fish populations in the Colorado River Basin, including within the action area. The USFWS SNARRC has been conducting research and propagation efforts for all four of the Colorado River endangered fish for decades. SNARRC has all four species on station and is actively propagating razorback sucker, Colorado pikeminnow, and bonytail for various recovery programs. While SNARRC is not engaged in active propagation activities for humpback chub, it is the only refuge population in the world for these fish species.

<u>Implementation</u>: SNARRC has identified a need to bring in more Colorado pikeminnow broodstock from the Upper Colorado River, from known locations, to augment genetic diversity of the fish. They also have identified a need to do genetics work on any new broodstock and existing fish. This measure will involve fish collection and genetic analysis in producing genetically healthy fish for their stocking program in the San Juan River. The benefit of this measure is to ensure a more diverse and robust genetic stock, thereby providing for higher survival rates in the wild population (Furr 2010; Ryden 2005).

The estimated cost for this measure would be $50,000 to $100,000 in the initial year to cover fish collection and genetics work. Reclamation, with input from the Science Team, would determine if the goal in FS-3 is met or if additional efforts are needed over the life of the action.

<u>Expected Benefits</u>: This measure will augment wild populations of Colorado pikeminnow and razorback sucker by offsetting the low recruitment rates for these species in the San Juan River. This measure also will assist in improving the genetic diversity of the brood stock and numbers of Colorado pikeminnow that would be used in stocking efforts in the San Juan River including areas affected by the NGS/proposed KMC Project, as well as in the Upper Colorado River. The benefit level will be quantified by the number Colorado pikeminnow with new genetics that would be available for future stocking. In addition, past stocking efforts will be evaluated to assist in determining the benefits of this measure.

<u>FS-4: Support Transport of Colorado Pikeminnow and Razorback Sucker Above the Waterfall Barrier in the San Juan River</u>

<u>Goals</u>: The objective of this measure is to provide financial support to capture and transport Colorado pikeminnow and razorback sucker upstream of a waterfall barrier in the San Juan River arm of Lake Powell to allow the fish access to habitat in the San Juan River. Funding to support the capture and transportation of these fish around this barrier would offset the effects of mercury and selenium by increasing the number of potentially spawning fish in the San Juan River and serve as a mechanism to connect the river and lake below the waterfall with fish and habitat in the river upstream of the barrier.

<u>Conservation Need</u>: For over 20 years a large waterfall (about 30 feet high) has existed in the San Juan River near Paiute Farms, Utah, where the river enters Lake Powell. The waterfall is present when Lake Powell reservoir elevations are below 3,660 feet, which has been continuous since 2000, except for a 1-month period in 2011. This waterfall serves as a barrier to movement for all fish species. While the waterfall effectively keeps nonnative fish from moving upriver, it also prevents native fish, especially Colorado pikeminnow and razorback sucker, from moving back upstream after they have drifted over the waterfall as larvae, juveniles, or adults. Ryden and Ahlm (1996) identified this barrier as a major impediment to migrating fish. In the spring of 2015, crews sampled below the waterfall on several occasions and encountered numerous endangered fishes, as described in the *Fiscal Year 2016 Annual*

Budget and Work Plan for San Juan River Basin Recovery Implementation Program (SJRRIP) (USFWS (2016b). One trip captured four untagged razorback suckers immediately below the waterfall via castnets (Chris Cheek, unpublished data cited in UDWR [2015]). A second trip deployed submersible and floating PIT-tag antennae and detected 338 individual fish, which included 319 razorback sucker, one bonytail, one Colorado pikeminnow, and 19 unidentified tags (Cathcart et al. unpublished data cited in UDWR [2015]).

In the spring of 2016 a one-time pilot program was conducted by Reclamation to relocate Colorado pikeminnow and razorback sucker over the waterfall using buckets to move PIT-tagged fish. Approximately 170 razorback sucker and 4 Colorado pikeminnow were collected and transported from this effort. Mobilizing equipment below the falls and moving the fish directly above the falls resulted in no fish mortality and less overall cost (McKinstry et al. 2016).

A fish ladder at the waterfall on NPS land was considered but the site was determined to be unsuitable due to a shifting river bed, lake level variability, high velocity flows, and accessibility. A fish ladder also would allow predatory nonnative fish from Lake Powell to move up into the San Juan River.

<u>Implementation</u>: This measure will provide funding to continue capture and transport of Colorado pikeminnow and razorback sucker upstream of a waterfall that blocks fish movement in the San Juan River. This measure will be implemented three times a year in March, April, and June, for a minimum of 3 years after 2019. Implementation of this measure will continue if determined to be appropriate by Reclamation with input from the Science Team. Effectiveness of this measure will be based largely on numbers of fish translocated above the falls which will therefore be provided the opportunity to seek out adequate habitat for a spawning in the river. The estimated cost for this measure is approximately $50,000 per year to cover trapping and netting fish at the waterfall, and holding PIT- and radio-tagged fish prior to transport around the waterfall three times per year.

Expected Benefits: The benefit of this measure will be to facilitate movement of wild, breeding adult razorback sucker and Colorado pikeminnow that are otherwise unable to reach their spawning areas in most years. Moving 1,000 razorback sucker per year for 5 years could result in millions of larval fish being produced, as these fish live as long as 40 years and reproduce at 3 to 4 years of age. The idea for this measure was developed in discussions for the implementation of the recovery plan for these species. Although Colorado pikeminnow numbers are not as large compared to razorback sucker, if even 10 fish were relocated into their critical habitat areas, this could contribute to recovery of the species. The recovery plans have identified barriers to movement and this would alleviate that situation during drought years. The San Juan Basin Recovery Implementation Program monitors these fish populations in the San Juan River and will be assessing movement of the PIT-tagged fish. The Science Team will assess the success rates of moving the listed fish species, and determine with the San Juan Basin Recovery Implementation Program and other experts how long to implement this conservation measure.

<u>*FS-5: Funding Support for a Habitat Improvement Project in the San Juan River*</u>

<u>Goals</u>: The objective of this measure is to provide funding to improve and provide habitat for Colorado pikeminnow and razorback sucker in the San Juan River, which would be used for nursery or recruitment areas for these species. This measure will offset Project-related impacts to Colorado pikeminnow and razorback sucker by providing habitat that currently is limited in the San Juan River, which will improve species recruitment, and by augmenting the physical habitat element of critical habitat for the species.

<u>Conservation Need</u>: The channel of the San Juan River has become incised and channelized from the following: 1) reductions in high flows due to construction and operation of Navajo Dam; and 2) the introduction and almost complete coverage of the riparian area with nonnative Russian olive. The Russian olive prevents higher flows from reworking the channel and reduces complexity along the

channel margins. Furthermore, this non-native vegetation armors the bank and prevents the development of native vegetation. Due largely to these conditions, complex habitats such as secondary channels and backwaters, which are important to early life stages of native fish, are limited within the San Juan River.

Ecological restoration of the San Juan River has been ongoing since 2009. Phase 1 of this effort, known as *The San Juan River Ecosystem Restoration Initiative Project,* was completed in 2013; Phase 2 was completed in 2015. The Nature Conservancy has managed and coordinated the effort with government agencies and the Navajo Nation on water flow management, restoring secondary channels and backwaters and removing nonnative fish and vegetation (McKinstry et al. 2016). Agencies provide input on specific site selection and design of the habitats through the San Juan Recovery Implementation Plan. Fish biologists from the New Mexico Department of Game and Fish and The Nature Conservancy are monitoring the Phase II restoration site for wild-spawned razorback suckers and Colorado pikeminnow, and have a remote PIT Tag antenna at the outflow of the restored channel. They have been detecting about 30 larval Colorado pikeminnow each year since the restoration was completed. In 2015, the remote antenna detected 300 individual pikeminnow and razorback suckers using the restored site (Zeigler 2016).

Implementation: This conservation measure will provide funding so that the habitat improvement effort could be continued after Phase 2 of the current program. Study locations and methods for the habitat improvement work will be based on previous restoration efforts in the San Juan River, as described in Bliesner et al. (2007). A three-step process will be followed to identify sites for constructing backwater areas. The initial step will involve screening of potential sites to meet the following criteria: 1) capable of providing stable site with flows ranging from 500 to 1,550 cubic feet per second; 2) external, controllable water source for flushing sediment; 3) accessible to stocking trucks; and 4) reasonable probability of land-owner permission for construction. The next step will be to conduct a field investigation of the potential sites to confirm that site criteria can be met. The last step in the site selection will be to conduct an evaluation of the potential sites for a ranking to meet site criteria and costs. After the site is selected, the restoration project will be constructed following previous methods used in the Phase 1 and Phase 2 work.

Approximately $50,000 per year would be set aside and made available to The Nature Conservancy to conduct habitat restoration for Colorado pikeminnow and razorback sucker. The average cost for channel restoration is approximately $25 per linear foot, and the $50,000 would produce 1,500 to 2,000 linear feet of habitat. This funding could contribute to other planned side-channel creation projects.

Expected Benefits: This measure will benefit razorback sucker and Colorado pikeminnow by improving and providing habitats that are currently limited in the San Juan River. The restoration habitats provide breeding and recruitment areas for Colorado pikeminnow, razorback sucker, and other sensitive native fish species, which increase reproduction and survival of eggs, larvae, and young. The benefit level will be quantified in terms of the area of improved habitat for the species in relation to similar type of habitat available for the species at the current time. Based on Phase 1 efforts or other similar projects, the amount of habitat improvement is estimated to be approximately 1,500 to 2,000 linear feet of backwater habitat per $50,0000 funding.

Humpback Chub

The impact issues analyzed for humpback chub include the potential effect of NGS emissions on the species and its critical habitat. Humpback chub was analyzed for NGS emission effects in the Northeast and Southwest Gap Regions. Critical habitat is located in both Gap Regions. Results for these study areas are summarized below.

Northeast Gap Region

The effect of the NGS emissions on humpback chub would be the same as discussed for bonytail. Tissue and HQ values are the same as those listed in **Table 3.13-14**.There would be a negligible effect on humpback chub tissue concentrations from either the 3-Unit Operation or 2-Unit Operation for mercury, as indicated by refined HQs of 0.002 and 0.001, respectively. The HQs for arsenic and selenium also would be considerably less than 1. Based on refined HQs being less than 1 for the NGS Proposed Action, a negligible effect is expected for humpback chub in the Northeast Gap Region. There would be no injury or loss of individual fish from arsenic, mercury, and selenium exposure.

The critical habitat analysis for humpback chub in the Northeast Gap Region related Project effects to the principal constituent elements (water, physical habitat, and biological environment). The Proposed Action would not affect the physical habitat component of critical habitat, because there is no direct disturbance or alteration of the river flow or substrate. There would be a negligible effect on the biological environment, because the ERA results indicated negligible risks to food sources for humpback chub (Ramboll Environ 2016c).

Based on the USFWS methodology described in Section 3.13.4.2, the analysis of the water element of critical habitat involved an evaluation of mercury and selenium concentrations in relation to the National Ambient Water Quality Criteria and Utah water quality standards. The evaluation of mercury and selenium is the same as discussed for bonytail. For both mercury and selenium, based on 3-Unit Operation (maximum) deposition concentrations, the project contribution results in a very small addition to the baseline concentration (less than 0.05 percent) and does not substantively affect the baseline condition. Therefore, the Proposed Action would represent a negligible effect on the water element of critical habitat in the Northeast Gap Region.

Southwest Gap Region

The NGS emission scenarios would contribute a negligible risk to humpback chub tissue concentrations from mercury, as indicated by refined HQs of 0.003 for the 3-Unit Operation and 0.002 for the 2-Unit Operation (**Table 3.13-19**). The combination of NGS and baseline conditions showed a refined mercury HQ of 0.7003 and 0.7002, respectively, for the two emission operations, which indicates a negligible risk to humpback chub. The NGS contribution to selenium concentrations in the Southwest Gap Region also is a negligible risk, with refined tissue-based HQs of 0.0003 and 0.002 for the two emission operations. The addition of NGS selenium emissions with baseline conditions showed refined HQs of 0.4003 and 0.4002 for the 3-Unit Operation and 2-Unit Operation, respectively. The NGS and baseline tissue concentrations also are less than the CBRs. The project contribution would be less than 1 percent of the total effect from the project and baseline fish tissue concentrations.

Table 3.13-19 Mercury and Selenium Tissue Concentrations for Humpback Chub in the Southwest Gap Region

Metal	CBR (mg/kg wet weight)	Baseline		3-Unit Operation		2-Unit Operation		3-Unit	2-Unit
		Conc. (mg/kg wet weight)	HQ	Conc. (mg/kg wet weight)	HQ	Conc. (mg/kg wet weight)	HQ	Contribution of Operation [1] (%)	
Mercury									
Maximum	0.2	0.17	0.8	0.0010	0.005	0.00070	0.003	0.0.12%	0.08%
Refined	0.2	0.15	0.7	0.00056	0.003	0.00038	0.002	0.10%	0.07%

Table 3.13-19 Mercury and Selenium Tissue Concentrations for Humpback Chub in the Southwest Gap Region

		Baseline		3-Unit Operation		2-Unit Operation		3-Unit	2-Unit
Metal	CBR (mg/kg wet weight)	Conc. (mg/kg wet weight)	HQ	Conc. (mg/kg wet weight)	HQ	Conc. (mg/kg wet weight)	HQ	Contribution of Operation [1] (%)	
Selenium									
Maximum	2	0.74	0.4	0.00082	0.0004	0.00055	0.0003	0.11%	0.07%
Refined	2	0.73	0.4	0.00052	0.0003	0.00035	0.0002	0.07%	0.05%

[1] Contribution of operation is the contribution of 3-Unit Operation and 2-Unit Operation to the Proposed Action (the sum of baseline and NGS operations).

CBR = critical body residue.

Species Effects – Based on population and toxicity data, the injury effects were estimated for humpback chub in the Southwest Gap Region by the USFWS methodology, which is described in **Appendix 3.13-A**. The results are considered an initial estimate by the USFWS, with final numbers to be finalized as part of the Biological Opinion. The effect quantification for the federally listed fish species was a separate analysis that provided an estimate of the number of individuals by life stage that could be affected by project emissions and deposition. The effect analysis also provides a separate line of evidence as to whether the listed fish would be affected by the project, and it is distinct from what was conducted for the ERAs, which identified potential risk of effects to species. The ERA results were used in determining whether an injury effect analysis should be completed. The ERAs do not quantify the effect on individuals. Both analyses used some of the same toxicity information such as threshold effect levels for mercury and selenium. However, the effect quantification applied toxicity information to population and life stage numbers to provide an estimate of number of individuals affected. The analysis estimated that up to one adult or subadult would be injured by the NGS Proposed Action emissions (**Table 3.13-20**). The impact on humpback chub is considered to be minor because less than 1 percent of the current humpback chub population within the Southwest Gap Region (11,300 adults) would be affected.

Table 3.13-20 Mercury and Selenium Injury Effects to Humpback Chub in the Southwest Gap Region, 2020 to 2074, 3-Unit Operation

	Life Stages[1] (number of individuals)						
Metal	Eggs/ Embryos	Larvae	Adult Reproduction	Juveniles Behavioral	Adults Behavioral	Subadult Survivor-ship	Adult Survivor-ship
Mercury	325	4	1	1	1	1	1
Selenium	41,415	2,238	13	NA[1]	NA[1]	NA[1]	NA[1]

[1] Toxicity literature is not available to provide an estimate for this category.

Critical Habitat Effects – The Proposed Action would not affect the physical habitat component of critical habitat for humpback chub, because there is no direct disturbance or alteration of the river flow or substrate. There could be a potential effect on the biological environment because the ERA analysis indicted the potential for risk from selenium on aquatic community (plant and invertebrate) food sources, as discussed in Section 3.12.4.3 of this EIS and the Gap Regions ERA (Ramboll Environ 2016c).

Based on the USFWS methodology described in Section 3.13.4.2, the effect of Proposed Action emissions on water quality on critical habitat in the Southwest Gap Region study area would be minor based on selenium exposure only. The maximum selenium surface water concentration in the Southwest Gap Region study area was 12 µg/L (total or unfiltered) and the refined concentration was 4.0 µg/L (based on the average, as the 95 % upper concentration limit exceeded the maximum). Ramboll Environ (2016c) estimated that the maximum NGS contribution would be 0.000838 µg/L (total selenium). The National Ambient Water Quality Criteria Water Quality Standard is 3.1 µg/L (dissolved basis), and the Arizona and Navajo Nation Water Quality Standards for selenium is 2 µg/L expressed on an unfiltered (total) basis. The dissolved selenium maximum surface water concentration (3 µg/L) was comparable to but below the water quality criteria for lotic systems (3.1 µg/L, dissolved) per *USEPA Selenium Ambient Water Quality Criteria* (USEPA 2016). Critical habitat would be affected by selenium, because the baseline selenium concentrations plus the small contribution from NGS emissions (which would contribute about 0.02% to 03% to refined and maximum total selenium concentration, respectively) would exceed the Navajo Nation and Arizona Water Quality Standards.

For mercury, maximum baseline dissolved concentrations in water were 0.00297 µg/L for total mercury and 0.00004 µg/L for methylmercury. Ramboll Environ (2016c) estimated that the maximum NGS contribution would be 0.000000486 µg/L (total mercury) and 0.00000013 µg/L (methylmercury). These mercury concentrations are well below the National Ambient Water Quality Criteria and the Arizona Water Quality Standard dissolved chronic water quality criteria of 2.4 µg/L. In addition, comparison of methylmercury concentrations to the CBR-based protective surface water concentration developed by the USFWS (0.0002 µg/L, dissolved) indicates no exceedance of maximum concentrations due to the baseline alone or in combination with the Proposed Action, with NGS contributing about 0.02% to the total mercury concentration and 0.3% for methyl mercury assuming maximum (3-Unit) operation. Therefore, there is no effect to humpback chub critical habitat due to mercury in surface water in the Southwest Gap Region study area.

In summary, the combination of the Proposed Action and baseline conditions would result in a minor effect on critical habitat for humpback chub from exposure to selenium. The effect would be considered minor, because the exceedance of the selenium water quality standards is minimal (2-fold based on refined concentration).

Applicant-committed protection measures would be implemented to mitigate for the potential minor effect of the Proposed Action, and provide additional conservation and recovery benefits to the humpback chub in the Southwest Gap Region. The Conservation Program and the conservation and monitoring measures for federally listed fish species are described in **Appendix 4A** of this EIS. Monitoring would be conducted and focus on mercury and selenium concentrations in the water column, sediment, and fish tissue in the San Juan River and Southwest Gap Region. For humpback chub, monitoring would be applicable only to the Southwest Gap Region. Details of the monitoring measure are described in **Appendix 4A** of this EIS. The following measures are applicable to humpback chub in the Colorado River below Glen Canyon Dam or its overall population in the Upper Colorado River. Benefits to the species also are discussed for each measure.

FS-1: Non-native Fish Management in the Colorado River Grand Canyon Area

Goals: The objective of this measure is to finance projects which offset Project-related impacts to humpback chub and razorback sucker by monitoring and removing nonnative fish within the action area. This measure will reduce adverse biological impacts of competitive and predatory nonnative fish on populations of listed fish species.

Conservation Need: Nonnative fish negatively impact populations of endangered humpback chub and razorback sucker within the action area through predation and competition. For example, in 2015, AGFD discovered green sunfish in the slough below Glen Canyon Dam. These sunfish may have been reproducing. The AGFD alerted the Grand Canyon National Park and Glen Canyon National Recreation Area of the presence of the sunfish. Despite a quick response time by the NPS staff, green sunfish were able to move elsewhere within the slough and potentially further downstream. The measure would ensure a rapid response to nonnative fish detections within the action area to prevent nonnative fish escapement to other riverine habitats. AGFD, USFWS and NPS currently monitor the Colorado River below Glen Canyon Dam, and the USFWS monitors critical areas of the watershed (e.g., Little Colorado River) that act as a conduit or source for nonnative fish. These agencies could provide a rapid response, dependent on availability of staff and materials.

Implementation: Reclamation would provide funds to augment detection monitoring for nonnative species, conducted by U.S. Geological Survey, NPS, AGFD, and USFWS, and to ensure availability of materials to those agencies engaged in nonnative fish removal. Funds will be provided to agencies annually (or as needed for rapid responses) for the purchase of chemicals, nets, and other equipment. Field implementation of nonnative fish removal will be as needed in response to detections.

Expected Benefits: The control of non-native fish in the Grand Canyon portion of the Colorado River would reduce predation on humpback chub and razorback sucker. The measure would help protect the entire mainstem Colorado River from Lees Ferry to the inflow to Lake Mead. The specific level of benefit to this reach will be determined from a qualitative analysis of the number of non-native fish removed and relative reduction in non-native fish predation in the area that is treated.

Razorback Sucker

The impact issue analyzed for razorback sucker is the potential effect of NGS Proposed Action emissions. Razorback sucker was analyzed for both Gap Regions and the San Juan River. Critical habitat for this species occurs in the San Juan arm of Lake Powell, San Juan River, and the Southwest Gap Region. It is known that that razorback sucker occurs in the Colorado and San Juan arms of Lake Powell and likely uses portions of the lake. Because the Near-field ERA study area does not extend to the arms of the lake, razorback sucker use of Lake Powell was analyzed in the Northeast Gap Region and San Juan River ERA study areas. Results for these areas are summarized below.

Northeast Gap Region

The effect of the NGS emissions on razorback sucker would be the same as discussed for bonytail. Tissue and HQ values are the same as those listed in **Table 3.13-11**.There would be a negligible effect on razorback sucker tissue concentrations from either the 3-Unit Operation or 2-Unit Operation for mercury, as indicated by refined HQs of 0.002 and 0.001, respectively. The HQs for arsenic and selenium also would be considerably less than 1. Based on refined HQs being less than 1 for the NGS Proposed Action, a negligible effect is expected for razorback sucker in the Northeast Gap Region. There would be no injury or loss of individual fish from arsenic, mercury, and selenium exposure or effect on critical habitat.

The critical habitat analysis for razorback sucker in the Northeast Gap Region related Project effects to the principal constituent elements (water, physical habitat, and biological environment). The Proposed Action would not affect the physical habitat component of critical habitat, because there is no direct disturbance or alteration of the river flow or substrate. There would be no effect on the biological environment, because the ERA results indicated HQs less than 1 for all fish and other aquatic community receptors that may be potential food sources of razorback sucker.

The USFWS analysis of the water element of critical habitat involved an evaluation of mercury and selenium concentrations in relation to the National Ambient Water Quality Criteria and Utah water quality standards. The evaluation of mercury and selenium is the same as discussed for bonytail. For both mercury and selenium, based on 3-Unit Operation (maximum) deposition concentrations, the project contribution results in a very small addition to the baseline concentration (less than 0.05 percent) and does not substantively affect the baseline condition. Therefore, the Proposed Action would represent a negligible effect on the water element of critical habitat in the Northeast Gap Region.

Southwest Gap Region

The Proposed Action would represent a negligible risk to razorback sucker tissue concentrations from mercury, as indicated by refined HQs well below 1 (0.003 for the 3-Unit Operation and 0.002 for the 2-Unit Operation) (**Table 3.13-21**). There also would be a negligible risk from selenium and arsenic on razorback sucker, as indicated by a refined HQ of 0.0003. When the small contribution from the NGS Proposed Action is added to baseline conditions, there would be a potential risk from mercury on razorback sucker in the Southwest Gap Region, as indicated by maximum and refined HQs that are slightly greater than 5 and 3, respectively. Using bluehead sucker, the maximum and refined HQs were 1 and 0.8, respectively, for mercury. The selenium analysis indicated a potential risk to flannelmouth sucker for both maximum and refined HQs, which were slightly greater than 1 when combining baseline conditions with NGS emissions. Although the maximum HQ was slightly greater than 1 for bluehead sucker, the refined HQ was less than 1. ERA results using stocked razorback sucker showed HQs less than 1. However, the surrogate analysis results were considered to be a more conservative approach to estimate potential exposure because stocked fish reared in a hatchery in different water quality conditions and with different food base may not bioaccumulate at the same levels of mercury as wild razorback sucker. The project contribution would be less than 1 percent of the total effect from the project and baseline fish tissue concentrations.

Table 3.13-21 Mercury and Selenium Tissue Concentrations for Razorback Sucker in the Southwest Gap Region

		Baseline		3-Unit Operation		2-Unit Operation		3-Unit	2-Unit
Metal/ Surrogate	CBR (mg/kg wet weight)	Conc. (mg/kg wet weight)	HQ	Conc. (mg/kg wet weight)	HQ	Conc. (mg/kg wet weight)	HQ	Contribution of Operation [1] (%)	
Mercury									
Flannelmouth sucker									
Maximum	0.2	0.98	5	0.0010	0.005	0.00070	0.003	0.11%	0.07%
Refined	0.2	0.67	3	0.00056	0.003	0.00038	0.002	0.08%	0.06%
Bluehead sucker									
Maximum	0.2	0.21	1	0.0010	0.005	0.00070	0.003	0.49%	0.33%
Refined	0.2	0.16	0.8	0.00056	0.003	0.00038	0.002	0.35%	0.23%
Selenium									
Flannelmouth sucker									
Maximum	2	2.9	1	0.00082	0.0004	0.00055	0.0003	0.03%	0.02%
Refined	2	2.5	1	0.00052	0.0003	0.00035	0.0002	0.02%	0.01%
Bluehead sucker									
Maximum	2	1.5	0.8	0.00082	0.0004	0.00055	0.0003	0.05%	0.04%
Refined	2	1.3	0.7	0.00052	0.0003	0.00035	0.0002	0.04%	0.03%

[1] Contribution of operation is the contribution of 3-Unit Operation and 2-Unit Operation to the Proposed Action (the sum of baseline and NGS operations).

CBR = critical body residue.

Species Effects – Based on population and toxicity data, the injury effects were estimated for razorback sucker in the Southwest Gap Region by the USFWS methodology, which is described in **Appendix 3.13-A**. The effect quantification for the federally listed fish species was a separate analysis that provided an estimate of the number of individuals by life stage that could be affected by project emissions and deposition. The effect analysis also provides a separate line of evidence as to whether the listed fish would be affected by the project, and it is distinct from what was conducted for the ERAs, which identified potential risk of effects to species. The ERA results were used in determining whether an injury effect analysis should be completed. The ERAs do not quantify the effect on individuals. Both analyses used some of the same toxicity information such as threshold effect levels for mercury and selenium. However, the effect quantification applied toxicity information to population and life stage numbers to provide an estimate of number of individuals affected. The results are considered an initial estimate by the USFWS, with final numbers to be finalized as part of the Biological Opinion. The analysis estimated that up to one adult or subadult would be injured by the NGS Proposed Action emissions (**Table 3.13-22**). The impact on razorback sucker is considered to be minor because less than 1 percent of the minimum viable razorback sucker population (5,800 adults as identified in USFWS [2002d] would be affected).

Critical Habitat Effects –Based on the USFWS methodology described in Section 3.13.4.2, the effects of the Proposed Action on critical habitat for razorback sucker in the Southwest Gap Region would be the same as discussed for humpback chub. There would be an effect from selenium on critical habitat, but there would be no expected effect from mercury. The effect from selenium would be considered minor, because the exceedance of the selenium water quality standards would be small (about 2-fold).

Table 3.13-22 Mercury and Selenium Injury Effects to Razorback Sucker in the Southwest Gap Region, 2020 to 2074, 3-Unit Operation

Metal	Life Stages[1] (number of individuals)						
	Eggs/ Embryos	Larvae	Adult Repro.	Juveniles Behavioral	Adults Behavioral	Subadult Survivor-ship	Adult Survivor-ship
Mercury	45	1	1	1	1	1	1
Selenium	20,403	1,249	1	NA[1]	NA[1]	NA[1]	NA[1]

[1] Toxicity literature is not available to provide an estimate for this category.

San Juan River

The Proposed Action would represent a negligible risk to razorback sucker in the San Juan River for arsenic, mercury, and selenium. The fish tissue HQs for the surrogate fish species are provided in **Table 3.13-23**. This analysis is based on bluehead and flannelmouth suckers as surrogates. ERA results using stocked razorback sucker are listed in **Table 3.13-24**. Both the surrogate and razorback tissue analyses showed very low HQs, which indicate a negligible risk to razorback sucker. As mentioned above, the surrogate HQs were used as a more conservative indicator of risks. The combination of NGS emissions from the 3-Unit Operation and 2-Unit Operation with baseline tissue concentrations showed refined HQs of slightly greater than 0.04 for arsenic, 0.6 for mercury, and 0.4 for selenium when using the highest surrogate HQs. These results indicated a negligible risk to razorback sucker for all three metals, as indicated by refined HQs less than 1. Both the species-specific and surrogate analyses indicated the project would contribute less than 1 percent of the total effect from the project and baseline fish tissue concentrations.

Table 3.13-23 Arsenic, Mercury, and Selenium Tissue Concentrations for Razorback Sucker Surrogates in the San Juan River

		Baseline		3-Unit Operation		2-Unit Operation		3-Unit	2-Unit
Metal / Species	**CBR (mg/kg wet weight)**	**Conc. (mg/kg wet weight)**	**HQ**	**Conc. (mg/kg wet weight)**	**HQ**	**Conc. (mg/kg wet weight)**	**HQ**	**Contribution of Operation [1] (%)**	
Arsenic[2]									
Flannelmouth sucker									
Maximum	5.5	0.32	0.06	0.00010	0.00002	<0.00010	<0.00002	0.002%	<0.002%
Refined	5.5	0.10	0.02	0.000086	0.00002	<0.000086	<0.00002	0.08%	<0.08%
Bluehead sucker									
Maximum	5.5	0.36	0.06	0.00010	0.00002	<0.00010	<0.00002	0.03%	<0.03%
Refined	5.5	0.2	0.04	0.000086	0.00002	<0.00008	<0.00001	0.04%	<0.04%
Mercury[2]									
Flannelmouth sucker									
Maximum	0.2	0.27	1	0.00012	0.0006	<0.00012	<0.0005	0.04%	<0.04%
Refined	0.2	0.1	0.6	0.000080	0.0004	<0.0008	<0.0004	0.08%	<0.08%
Bluehead sucker									
Maximum	0.2	0.096	0.5	0.00012	0.0006	<0.00012	<0.0006	0.12%	<0.12%
Refined	0.2	0.05	0.2	0.000080	0.0004	<0.0001	<0.0004	0.16%	<0.16%
Selenium									
Flannelmouth sucker									
Maximum	2	2.5	1	0.00026	0.0001	0.00018	0.00009	0.01%	0.01%
Refined	2	0.81	0.4	0.00024	0.0001	0.00016	0.00008	0.03%	0.02%
Bluehead sucker									
Maximum	2	1.6	0.8	0.00026	0.0001	0.00018	0.00009	0.02%	0.01%
Refined	2	0.61	0.3	0.00024	0.0001	0.00016	0.00008	0.04%	0.03%

1 Contribution of operation is the contribution of 3-Unit Operation and 2-Unit Operation to the Proposed Action (the sum of baseline and NGS operations).

2 For the 2-Unit Operation, arsenic and mercury concentrations were less than the 3-Unit Operation but below the computational limit of the Electric Power Research Institute model and so could not be calculated. Therefore, tissue concentrations the 3-Unit Operation concentrations were conservatively used for the 2-Unit Operation.

CBR = critical body residue.

Table 3.13-24 Arsenic, Mercury, and Selenium Tissue Concentrations for Razorback Sucker in the San Juan River

		Baseline		3-Unit Operation		2-Unit Operation		3-Unit	2-Unit
Metal	**CBR (mg/kg wet weight)**	**Conc. (mg/kg wet weight)**	**HQ**	**Conc. (mg/kg wet weight)**	**HQ**	**Conc. (mg/kg wet weight)**	**HQ**	**Contribution of Operation [1] (%)**	
Arsenic[2]									
Maximum	5.5	0.34	0.06	0.00010	0.00002	<0.00010	<0.00002	0.03%	<0.03%
Refined	5.5	0.22	0.04	0.000086	0.00002	<0.000086	<0.00002	0.04%	<0.04%

Table 3.13-24 Arsenic, Mercury, and Selenium Tissue Concentrations for Razorback Sucker in the San Juan River

Metal	CBR (mg/kg wet weight)	Baseline		3-Unit Operation		2-Unit Operation		3-Unit	2-Unit
		Conc. (mg/kg wet weight)	HQ	Conc. (mg/kg wet weight)	HQ	Conc. (mg/kg wet weight)	HQ	Contribution of Operation [1] (%)	
Mercury[2]									
Maximum	0.2	0.15	0.7	0.00012	0.0005	<0.00012	<0.0005	0.08%	<0.08%
Refined	0.2	0.09	0.4	0.00008	0.0004	<0.00008	<0.0004	0.09%	<0.09%
Selenium									
Maximum	2	2.3	1	0.00026	0.0001	0.00018	0.00009	0.01%	0.01%
Refined	2	0.95	0.5	0.00024	0.0001	0.00016	0.00008	0.02%	0.02%

[1] Contribution of operation is the contribution of 3-Unit Operation and 2-Unit Operation to the Proposed Action (the sum of baseline and NGS operations).

[2] For the 2-Unit Operation, arsenic and mercury concentrations were less than the 3-Unit Operation but below the computational limit of the Electric Power Research Institute model and so could not be calculated. Therefore, tissue concentrations the 3-Unit Operation concentrations were conservatively used for the 2-Unit Operation.

CBR = critical body residue.

Species Effects – Based on population and toxicity data, the injury effects were estimated for razorback sucker in the San Juan River by the USFWS methodology, which is described in **Appendix 3.13-A**. The results are considered an initial estimate by the USFWS, with final numbers to be finalized as part of the Biological Opinion. The effect quantification for the federally listed fish species was a separate analysis that provided an estimate of the number of individuals by life stage that could be affected by project emissions and deposition. The effect analysis also provides a separate line of evidence as to whether the listed fish would be affected by the project, and it is distinct from what was conducted for the ERAs, which identified potential risk of effects to species. The ERA results were used in determining whether an injury effect analysis should be completed. The ERAs do not quantify the effect on individuals. Both analyses used some of the same toxicity information such as threshold effect levels for mercury and selenium. However, the effect quantification applied toxicity information to population and life stage numbers to provide an estimate of number of individuals affected. The analysis estimated that up to 1 adult and 5 subadults would be injured by the NGS Proposed Action emissions (**Table 3.13-25**). The impact on razorback sucker is considered to be minor because less than 1 percent of the minimum viable razorback sucker population (5,800 adults as identified in USFWS [2002d] would be affected).

Table 3.13-25 Mercury and Selenium Injury Effects to Razorback Sucker in the San Juan River, 2020 to 2074

Metal	Life Stages[1] (number of individuals)						
	Eggs/ Embryos	Larvae	Adult Repro.	Juveniles/ Adults (<400 mm)	Juveniles/ Adults (>400 mm)	Subadult Behavioral Injury	Adult Behavioral Injury
Mercury	4,510	72	1	5	2	1	1
Selenium	291,510	301	NA[1]	NA[1]	6	NA[1]	NA[1]

[1] Toxicity literature is not available to provide an estimate for this category.

mm = millimeter.

Critical Habitat Effects –The Proposed Action would not affect the physical habitat component of critical habitat, because there is no direct disturbance or alteration of the river flow or substrate. Based on the ERA analysis, the biological environment related to food sources for razorback sucker (benthic invertebrates and algae) would not be affected by arsenic, mercury, or selenium concentrations in the water or sediment.

Based on the USFWS methodology described in Section 3.13.4.2, the effect of Proposed Action emissions on water quality in the San Juan River could result in a potential for adverse effects on razorback sucker critical habitat, based on selenium surface water concentrations in excess of the applicable water quality standards. The results are the same as those discussed for Colorado pikeminnow in the San Juan River. The effect would be considered minor, because the exceedance of the selenium Navajo Nation Surface Water Quality Standard was small.

Colorado River below Glen Canyon Dam

Conservation and monitoring measures for razorback sucker in the Colorado River below Glen Canyon Dam would include two measures that were discussed for humpback chub. These include FS-1 (Non-native Fish Management in the Colorado River Grand Canyon Area) and Monitoring-1 (Mercury and Selenium Monitoring to Confirm NGS/proposed KMC Project Model Predictions). In addition, the following measure also would apply to razorback sucker.

FS-2: Razorback Sucker Translocations

Goals: The objective of this measure is to augment razorback sucker numbers in the Grand Canyon portion of the Colorado River through translocations, if the NPS and USFWS determine the species needs augmentation. If translocations are determined by NPS and USFWS to be needed, this measure will offset Project-related impacts to razorback sucker by increasing razorback sucker numbers in the Grand Canyon.

Conservation Need: Recruitment of razorback sucker in the lower Grand Canyon appears to be limited, despite the presence of larvae in 2014 and 2015. Factors limiting recruitment are uncertain. Reclamation funded a review and summary of razorback sucker habitat in the Colorado River System in 2012. This summary presents a preliminary evaluation of potential razorback sucker habitat in the lower Grand Canyon. The study identifies the complex habitat that razorback suckers require, such as backwaters, islands and percent vegetation cover that was a deciding factor for NPS to consider a translocation effort (Valdez et al. 2012). This conservation measure would support two potential outcomes for razorback sucker in the Grand Canyon portion of the Colorado River, as discussed in the NPS Comprehensive Fisheries Management Plan (NPS 2013): RBS2, which states that *razorback sucker are present in substantial numbers in the Colorado River Fish Management Zones, but are not reproducing*; and RBS3 stating that *suitable razorback sucker habitat is available, but few individuals are present and no reproduction.*

Implementation: Reclamation and the Science Team will coordinate with the Lower Colorado River Multi-species Conservation Program, USFWS, and NPS regarding any proposed translocation effort. Translocation efforts will be determined by an NPS assessment of the availability of suitable habitat for razorback sucker in the action area. If NPS and USFWS determine that the razorback sucker needs augmentation, then the Science Team will support that effort by assisting in the capture, rearing, stocking, translocation or augmentation as appropriate for the species. If NPS and the USFWS determine that the canyon habitat is unsuitable for razorback sucker, then no translocations would occur, FS-2 would not be implemented, and funds would be diverted to FS-1 to further augment nonnative fish removal. As a result of this scenario, listed fish species will continue to benefit from nonnative fish removal under FS-1.

FS-2 will use wild spawned larvae which are currently being raised in ponds. In addition to using wild-spawned larvae, larval fish could be collected from Lake Mead and other areas and then PIT-tagged and released at a tributary mouth or mainstem portion of the Colorado River or the Lake Mead inflow area.

The estimated cost for this measure is $75,000 per year to cover capturing of larvae, rearing fish in ponds, harvesting fish for stocking, transporting fish to stocking locations, and additional monitoring of fish (radio- and PIT-tagging). Reclamation, in coordination with NPS and the Science Team, will determine through monitoring if translocations should continue, for how long and if this is succeeding, or be discontinued. Implementation of these activities will be conducted in close coordination with the USFWS.

Expected Benefits: This measure would be related to the razorback sucker outcomes identified above by the NPS. Benefits of FS-2 are related to the razorback sucker outcomes and NPS phased adaptive management strategies described in the NPS Comprehensive Fisheries Management Plan. Depending on the outcomes for razorback sucker, NPS will implement the following studies:

- Phase I (Years 1-3) – Conduct fish community survey of the Colorado Fish Management Zones including larval fish and large-bodies fish;
- Phase II (End of Year 3) – Evaluate data collected in years 1-3 to identify whether sonic-tagged fish remained in the area, and razorback sucker presence/absence; and
- Phase III (Year 4) – If Phase II results show substantial numbers (25 percent) of sonic-tagged razorback sucker remain, or razorback sucker presence (larvae or other unmarked adults), or evidence of Lake Mead's population expanding into Grand Canyon, then establish a long-term monitoring program in the Colorado River Fish Management Zones. Plans to augment razorback sucker in the Colorado River Fish Management Zones would be suspended if evidence of increasing abundance or expansion of Lake Mead into the Colorado River Fish Management Zones. The established workgroup could convene to recommend continuing augmentation and implementation when there is a presence in the Lake Mead area but no evidence of expansion.

The benefit to razorback sucker will be expressed in terms of the percent increase in the expanded range for razorback sucker as a result of the translocation efforts compared to the current miles of occupied habitat. This measure may result in new breeding, spawning, and young-of-the-year nursery areas.

San Juan River

Conservation and monitoring measures for razorback sucker in the San Juan River would include three measures that were discussed for Colorado pikeminnow. These include FS-3 (Support Activities at the USFWS Southwest Native Aquatics Research and Recovery Center); FS-4 (Support Transport of Colorado Pikeminnow and Razorback Sucker above the Waterfall Barrier in the San Juan River); and FS-5 (Funding Support for a Habitat Improvement Project in the San Juan River). Benefits to razorback sucker in the San Juan River from these measures would be the same as discussed for Colorado pikeminnow. Monitoring also would be conducted and focus on mercury and selenium concentrations in the water column, sediment, and fish tissue in the San Juan. Details of the monitoring measure are described in **Appendix 4A** of this EIS.

Kanab Ambersnail

The impact issue analyzed for Kanab ambersnail is the potential effect of NGS and other cumulative emissions on the species. This species was analyzed for the Southwest Gap Region where it occurs in a riverside spring called Vasey's Paradise and Upper Elves Canyon within Grand Canyon National Park. Because the Kanab ambersnail is located in spring habitats that are located outside of the Colorado

River channel, and because these habitats would be unaffected by direct or indirect emission deposition (i.e., no surface water runoff from the watershed which could contain NGS pollutants) there is no direct linkage and therefore no potential of NGS to effect this species.

3.13.4.3.1.2 Other Special Status Aquatic Species

<u>Bluehead Sucker and Flannelmouth Sucker</u>

The impact issue analyzed for bluehead sucker and flannelmouth sucker is the potential effect of NGS on these species in Lake Powell, the Gap Regions, and the San Juan River. Flannelmouth sucker occurs in these portions of the overall study area. Bluehead sucker is present in all areas except Lake Powell.

<u>Lake Powell</u>

One non-federal listed special status species, flannelmouth sucker, was analyzed for Lake Powell. The ERA results for all fish species in Lake Powell indicated a negligible effect from the Proposed Action by themselves or in combination with baseline conditions, based on maximum and refined HQs being less than 1 as discussed in Section 3.12.4.3 of this EIS and ERA results presented in Ramboll Environ (2016a).

<u>Gap Regions</u>

The effect of the NGS emissions on these sucker species in the Northeast Gap Region would be the same as discussed for bonytail, humpback chub, Colorado pikeminnow, and razorback sucker. There would be a negligible effect on these species from either the 3-Unit Operation or 2-Unit Operation for mercury fish tissue concentrations, as indicated by HQs less than 1. The combination of NGS emissions and baseline tissue concentrations also would be negligible, based on maximum and refined HQs less than 1 (Ramboll Environ 2016c).

The Southwest Gap Region analysis indicated that the NGS emission scenarios would contribute a negligible effect on these species' tissue concentrations from mercury (**Table 3.13-21**). The combination of NGS and with baseline conditions for flannelmouth sucker showed HQs slightly greater than 3 for mercury and 1 for selenium, which indicates that there would be a potential minor effect. There also would be a potential selenium effect on flannelmouth sucker tissue concentrations, as indicated by HQs exceeding 1. HQs for bluehead sucker were below 1 for both mercury and selenium, which indicates a negligible effect. Potential effects on flannelmouth sucker are considered minor because the injury or loss of individuals would be less than the overall population numbers.

<u>San Juan River</u>

The San Juan River analysis indicated that NGS emission scenarios would contribute a negligible effect on bluehead and flannelmouth sucker tissue concentrations from mercury and selenium. NGS emissions by themselves would represent a negligible effect on these species. The combination of NGS and baseline fish tissue concentrations for bluehead sucker and flannelmouth sucker would result in a negligible effect on the species, because HQs were less than 1 (**Table 3.13-23**).

<u>Speckled Dace</u>

The impact issue analyzed for speckled dace is the potential effect of NGS in the Gap Regions and the San Juan River.

Gap Regions

Emissions and deposition from the Proposed Action would result in a negligible effect on speckled dace tissue in the Northeast and Southwest Gap Regions, as indicated by refined HQs less than 0.01 for mercury and selenium in the Northeast Gap Region and less than 0.001 for arsenic, mercury, and selenium in the Southwest Gap Region. Project emissions by themselves would not result in injury effects on the species. The combination of the Proposed Action emissions in the Southwest Gap Region would result in a minor effect on speckled dace for mercury and selenium, as indicated by a maximum and refined HQ of 2. There could be injury effects on the species; however, the magnitude would be low when considering the relatively large population numbers assumed for this species in the Southwest Gap Region.

San Juan River

Emissions from the Proposed Action also would contribute a negligible on speckled dace tissue in the San Juan River, as indicated by refined HQs of 0.0005 for arsenic, 0.0002 for mercury, and 0.0001 for selenium. The combination of NGS with baseline emissions would result in a minor effect on speckled dace from selenium (HQ of 1). There would be a negligible effect to speckled dace from mercury, because the HQ was less than 1. There could be injury effects to the species, however, the magnitude would be low when considering the relatively large population numbers for this species in the San Juan River.

Northern Leopard Frog

Northern leopard frog also was analyzed for the Southwest Gap Region qualitatively due to a general lack of toxicity data for amphibians. The line of evidence used for this species was a comparison of metal concentrations in the Colorado River downstream of Glen Canyon Dam compared to National Ambient Water Quality Criteria and literature-based toxicity data protective of the larval (tadpole) development stage (Sparling et al. 2010). The food pathway for juvenile and adult stages is primarily insects, which is similar to fish species such as rainbow trout. The qualitative analysis for northern leopard frog concluded a negligible effect from mercury, based on the negligible contributions from NGS emissions (Ramboll Environ 2016c).

3.13.4.3.2 Proposed Kayenta Mine Complex

Northern leopard frog also was evaluated within the proposed KMC portion of the study area. Northern leopard frog was analyzed for the potential effect of emissions from the proposed KMC facilities. The qualitative analysis used largemouth bass as an indicator of potential effects for northern leopard frog. When considering that the maximum concentrations of COPECs resulted in HQs below 1 for fish emissions from the proposed KMC facilities, effects on northern leopard frog would be considered negligible.

Groundwater modeling was conducted to determine if N-Aquifer pumping could affect flows in streams and springs within the study area for the proposed KMC facilities. Modeling indicated that there would only be a reduction in stream base flow relative to 2020 flow rates for the Proposed Action (3-Unit Operation and 2-Unit Operation) in Begashibito Wash, which provides water for potential northern leopard frog habitat in Cow Spring. Modeling also indicated that there could be a small reduction in groundwater levels (less than 0.02 feet) at spring features in the nearby Cow Springs locale. Based on the model simulations, Proposed Action pumping would result in very small effects on potential habitat for northern leopard frog. The small magnitude of the potential reduction in spring flow would be a negligible effect northern leopard frog. Over the projected 2020 through 2110 model simulation period, proposed pumping at proposed KMC would comprise less than 1 percent of the total projected cumulative pumping. There would be less than a 1 percent reduction in stream flow relative to 2020 rates within the cumulative study area from project pumping.

3.13.4.3.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

3.13.4.3.3.1 Federally Listed Aquatic Species

Colorado Pikeminnow

An experimental-non-essential Colorado pikeminnow population exists in the Verde River downstream of the STS crossing. Fish are present due to stocking efforts but individuals do not persist after 1 or 2 years. Recent stocking in January 2016 included 266 pikeminnow at the Beasley Flat location, which is approximately 45 miles downstream of the STS ROW. No effects of transmission line operation or maintenance would be expected because the distance from any individuals/suitable habitat to the ROW is great enough that any minimal additional sedimentation into the river from the access road would be indistinguishable from baseline levels in the river. In addition, best management practices would be applied to avoid or minimize impacts on special status fish species, as described in the U.S. Forest Service Phase II Biological Assessment and Biological Opinion (USFWS 2008c; U.S. Forest Service 2008).

Desert Pupfish

The impact issue analyzed for desert pupfish is the potential effect of maintenance and operation of the STS on the species at the Agua Fria crossing. No desert pupfish occur in the STS crossing of the Agua Fria crossing. Although apparently suitable aquatic habitat occurs along the STS ROW, these areas are limited, and are likely degraded due to human activity or the persistence of nonnative species. Operation and maintenance activities within riparian habitat associated with the Agua Fria River would not occur, as no transmission structures or access roads are located within the riverbed. Occupied habitat for desert pupfish are located in a remote drainage upstream of the project study area, further precluding sediment or runoff effects to habitat.

Furthermore, the implementation of conservation measures for the survey, flagging, and avoidance of known populations. Operation and maintenance activities would not occur within known occupied habitat, given that no transmission infrastructure or roads are located in suitable aquatic habitat for desert pupfish. In addition, the implementation of sediment control, spill control and containment, and an agency-approved herbicide treatment plan, would further ensure that impacts to aquatic habitats are avoided. As a result of the applicant-committed protection measures listed below, there would be no effect of the operation and maintenance activities on desert pupfish.

- Biologically sensitive areas identified by the USFWS and other federal land managers would be mapped prior to maintenance activities. Appropriate measures would be implemented to avoid and/or minimize impacts to known populations of federally listed or other special status species.
- Conservation measures would be implemented on National Forest System lands to minimize impacts to federally listed species and their critical habitat. Aquatic species would include loach minnow, Gila topminnow, and Gila chub. The relevant National Forest crossed by the STS is Coconino.
- Standard Best Management Practices involving spill prevention and capture, storm water runoff control, and erosion control would be implemented during repairs to prevent degradation of surface waters.
- Staging areas for loading and unloading equipment would be located in previously disturbed areas and outside of floodplains and wet areas.

During repairs and maintenance of project infrastructure, standard BMPs to prevent degradation of surface waters (i.e., spill prevention and capture plans, storm water runoff controls, silt fencing and straw bales, and sediment and erosion controls) would be implemented.

Gila Chub

The impact issue analyzed for Gila chub is the potential effect of maintenance and operation of the STS on the species at the Verde and Agua Fria river crossings. No Gila chub records are known from within the action area. Although suitable habitat may occur within the Verde and Agua Fria rivers, Project-related activities would not affect these habitats. In the area where the STS crosses the Verde River, the transmission line spans the river canyon approximately 400 feet above the river itself, no vegetation management or other maintenance activities would be required in or adjacent to the river. The Verde River in this segment is narrow, incised, and more than 300 feet below the STS conductors; therefore, the need to conduct maintenance or vegetation management within the Verde River riparian corridor is unlikely. No access roads or other STS equipment occur within 100 feet of the cut bank of the canyon.

At the northern and middle Agua Fria crossings, the STS spans the river canyon. The lines are approximately 100 feet above the active floodplain at the northern crossing and 200 feet above the active floodplain at the southern crossing. The portion of the line that parallels the river is located within 600 feet of the river bottom, but the towers are located on bluffs ranging from 50 to over 300 vertical feet above the active floodplain. The height of these two crossings precludes the need to manage riparian vegetation along the river bottom. Similarly, the topography along the portion of the line that parallels the river, combined with the relatively low stature of upland vegetation in this area, would prevent the need to clear or trim vegetation or perform any surface-disturbing maintenance activities that could affect Gila chub or its habitat. In addition, the same conservation measures listed for desert pupfish also would be applicable to Gila chub. Based on the Phase II Utility Maintenance in Utility Corridors on Arizona Forests, July 17, 2008, (AESO/SE 22410- 2007-F-0365), the following measure also would be implemented: utilities would implement the BMPs measures to reduce ground disturbance and the spread of noxious weeds, which would reduce impacts and ensure that effects to listed fish and their designated critical habitat would be minimized. Consequently, continued operation and maintenance of the STS would not affect the Gila chub or its habitat.

Gila Topminnow

The impact issue analyzed for Gila topminnow is the potential effect of maintenance and operation of the STS on the species at the Agua Fria River crossing. No Gila topminnow occur in the project study area. Although apparently suitable aquatic habitat occurs along the STS ROW, these areas are limited, and are likely degraded due to human activity or the persistence of nonnative species. As discussed previously for Gila chub, Operation and maintenance activities within riparian habitat associated with the Agua Fria River would not occur, as no transmission structures or access roads are located within the riverbed. Occupied habitat for Gila topminnow is located in a remote drainage upstream of the action area, further precluding sediment or runoff effects to habitat. Furthermore, conservation measures would be implemented for the survey, flagging, and avoidance of known populations. Operation and maintenance activities would not occur within known occupied habitat, given that no transmission infrastructure or roads are located in suitable aquatic habitat for Gila topminnow. In addition, the implementation of sediment control, spill control and containment, and an agency-approved herbicide treatment plan, would further ensure that impacts to aquatic habitats are avoided. Finally, conservation measures applicable to Gila chub also would provide protection to Gila topminnow, as the two species are often found in the same springs, wetlands, and refugia.

Loach Minnow

The impact issue analyzed for loach minnow is the potential effect of maintenance and operation of the STS on critical habitat for loach minnow at the Verde River crossing. No loach minnow are known to occur in the action area. The Verde River contains suitable and critical habitat for the species. As discussed previously for numerous species (see Gila Chub section, above), the Proposed Action would have no effect on suitable or designated critical habitat within the riparian area of the Verde River. The conservation measures listed above further ensure that BMPs for fueling and habitat disturbance would avoid impacts to the species.

Razorback Sucker

The Verde River crossing by the STS is located approximately 10 miles upstream of critical habitat for razorback sucker. In the area where the STS crosses the Verde River, the transmission line spans the river canyon approximately 400 feet above the river itself, no vegetation management or other maintenance activities would be required in or adjacent to the river. The Verde River in this segment is narrow, incised, and more than 300 feet below the STS conductors; therefore, the need to conduct maintenance or vegetation management within the Verde River riparian corridor is unlikely. No access roads or other STS equipment occur within 100 feet of the cut bank of the canyon. As discussed in the Phase II Maintenance in Utility Corridors on Arizona Forests (U.S. Forest Service 2008), best management practices would be required to reduce impacts to razorback sucker and its critical habitat to a level that is insignificant and discountable. When considering that critical habitat for razorback sucker is located 10 miles downstream of the crossing in combination the fact that vegetation management and disturbance would not occur at or near the Verde River crossing , there would be no impacts to razorback sucker or its critical habitat (USFWS 2008c; U.S. Forest Service 2008).

Roundtail Chub

The impact issue analyzed for roundtail chub (i.e., distinct population segment) is the potential effect of maintenance and operation of the STS on the species at the Verde River crossing. Potential impacts would be the same as discussed for spikedace, except no critical habitat is designated for roundtail chub. By implementing best management practices, applicant-committed protection measures, and additional conservation measures, operation and maintenance activities would result in negligible effects on roundtail chub because effects are not measurable.

Spikedace

The impact issue analyzed for spikedace is the potential effect of maintenance and operation of the STS on the species at the Verde River crossing. No spikedace are known to occur in the action area, although the STS crossing at the Verde River is presumed occupied. The Verde River contains suitable and critical habitat for the species. As discussed previously for numerous species (see desert sucker and Gila chub above), the Proposed Action would have no effect on suitable or designated critical habitat within the riparian area of the Verde River. Additional conservation measures involving fuel restrictions and coordination with the USFWS regarding vegetation treatment within critical habitat would be required as described for loach minnow. One additional conservation measure will be implemented for spikedace: low water crossings will not be used in the Upper Verde River. Best management practices would be required to avoid impacts to spikedace and its critical habitat to a level that is insignificant and discountable (U.S. Forest Service 2008). Because the spikedace and loach minnow critical habitat both occur at the STS crossing at the Verde River, the conservation measures proposed for the loach minnow also would be protective of spikedace. Therefore, impacts to critical habitat would be avoided.

Virgin River Chub

The impact issue analyzed for Virgin River chub is the potential effect of maintenance and operation of the WTS on the species at the Virgin and Muddy river crossings. For clarification, the Virgin River chub population in the Muddy River is not part of the federal listing or critical habitat designation for this species at this time. However, the Virgin River is part of the federal listing and contains critical habitat for this species. The WTS spans the Virgin River at a height of more than 300 feet, and transmission structures are located outside of the riparian habitat. Therefore, there would be no effect to stream habitat because no routine maintenance or vegetation management activities would occur within the stream corridor crossed by the WTS. Although operation and maintenance of the WTS ROW near the Muddy River could result in potential sedimentation and vehicles and equipment activity from herbicide treatment, the conservation measures described above for other fish species would avoid the potential for these effects.

Woundfin

The impact issue analyzed for woundfin is the potential effect of maintenance and operation of the WTS on the species at the Virgin River crossing. The WTS spans the Virgin River at a height of more than 300 feet, and transmission structures are located outside of the riparian habitat. Therefore, there would be no effect to stream habitat because no routine maintenance or vegetation management activities would occur within the stream corridor crossed by the WTS. The conservation measures described above in combination with the site conditions at the WTS crossing would avoid effects to woundfin and its critical habitat at the Virgin River crossing.

3.13.4.3.3.2 Other Special Status Aquatic Species

Non-federally listed special status species that were analyzed for the transmission lines included the following:

- WTS – desert sucker (Virgin River), flannelmouth sucker (Colorado and Virgin rivers), Meadow Valley Wash desert sucker (Meadow Valley Wash and Muddy rivers), Meadow Valley Wash speckled dace (Meadow Valley Wash and Muddy rivers), Moapa speckled dace (Muddy River), western (boreal) toad (Muddy River), speckled dace (Colorado, Paria, and Virgin rivers), Virgin spinedace (Virgin River), Arizona toad (Muddy and Virgin rivers), Great Plains toad, northern leopard frog (Paria River), and Niobrara ambersnail (Gyspum Wash); desert springsnail (Virgin River); and
- STS – speckled dace (Verde River).

The types of impacts on these special status species would be the same as discussed for Gila chub for species occurring along STS and for Virgin River chub for species occurring along the WTS. Operation and maintenance activities for streams adjacent to or crossed by transmission line ROWs could result in potential sedimentation, spill risks from vehicles and equipment, and herbicide treatment, which could adversely affect these species for a short-term duration. As discussed for desert pupfish, applicant-committed protection measures would be implemented to avoid or reduce effects on aquatic species. A key measure would involve mapping of biologically sensitive areas prior to maintenance activities, with appropriate measures implemented to avoid and/or minimize impacts to known populations of special status aquatic species. Impacts would be considered minor as a result of the protection measures.

3.13.4.3.4 Project Impact Summary – All Project Components

In summary, the effects of the Proposed Action on special status aquatic species were considered minor based on the low number of fish that could be injured and the small percentage of fish population numbers potentially affected. In addition, there would be minor effects on critical habitat for Colorado pikeminnow and razorback sucker in the San Juan River and humpback chub and razorback sucker in the Southwest Gap Region, because the level of exceedance of water quality standards for mercury and selenium was small. NGS emissions by themselves represent a negligible risk on all species, as indicated by the very small HQ values. The combination of NGS emissions and baseline conditions would result in potential risks to Colorado pikeminnow in the San Juan River and razorback sucker in the Southwest Gap Region. Effects on all special status species in the Northeast Gap Region would be negligible, as indicated by the HQs being less than 1 for NGS and baseline emissions. The implementation of conservation measures for the San Juan River and the Colorado River below Glen Canyon Dam would be used to benefit the species in terms of control of non-native species (Colorado River below Glen Canyon Dam), translocation efforts (San Juan River and Colorado River below Glen Canyon Dam), and habitat enhancements (San Juan River). Conservations measures would be implemented to offset impacts of the Proposed Action and enhance and assist in the recovery of affected species in the Southwest Gap Region and San Juan River. The following summary is provided for federally listed species.

- Bonytail – There would be a negligible risk to bonytail in the Northeast Gap Region from the Proposed Action emissions and baseline conditions because the baseline fish tissue concentrations of mercury and selenium are below impact thresholds and the project contributes a negligible amount of mercury and selenium to this area. There would be a negligible effect on critical habitat, because the project and baseline mercury and selenium concentrations do not exceed the National Ambient Water Quality Criteria.
- Colorado Pikeminnow – The Proposed Action would contribute very small metal concentrations to Colorado pikeminnow tissue and its critical habitat in the Northeast Gap Region and San Juan River. The Proposed Action contribution would combine with baseline fish tissue concentrations, which would result in a minor effect from mercury on Colorado pikeminnow in the San Juan River, with an estimated injury of up to 1 adult over the 2020 to 2074 time frame of the project. The impact on the species is considered to be minor because less than 1 percent of the current Colorado pikeminnow adult population in the San Juan River would be affected by the Proposed Action in combination with baseline fish tissue concentrations. There would be a negligible effect in the Northeast Gap Region from the project and baseline conditions because the baseline fish tissue concentrations for mercury and selenium are below impact thresholds and the project contributes a negligible amount of mercury and selenium to this area. There would be a negligible effect on critical habitat in the Northeast Gap Region, because the project and baseline mercury and selenium concentrations do not exceed the National Ambient Water Quality Criteria. There would be a minor effect on the water element of critical habitat in the San Juan River. Although the conservative Navajo Nation mercury water quality standard was exceeded, no measured surface water concentration (including the maximum) was in excess of the National Ambient Water Quality Criteria.
- Humpback Chub – The Proposed Action would contribute small metal concentrations to humpback chub tissue and its critical habitat in the Northeast and Southwest Gap Regions. The Proposed Action contribution combined with baseline conditions would result in a minor effect on humpback chub in the Southwest Gap Region, as indicated by an estimated injury effect of up to 1 adult over the 2020 to 2074 time frame of the project. The impact on the species is considered to be minor because less than 1 percent of the current humpback chub adult population within the Southwest Gap Region would be affected by the Proposed Action in combination with baseline fish tissue concentrations. There would be a negligible effect in the Northeast Gap Region from the project and baseline conditions because the baseline fish tissue concentrations of mercury and selenium are below impact thresholds and the project contributes a negligible amount of mercury and selenium to this area. There would be a negligible effect on critical habitat in the Northeast Gap Region, because the project and baseline mercury and selenium concentrations do not exceed the National Ambient Water Quality Criteria. There would be a minor effect on the water element of critical habitat in the Southwest Gap Region, based on exceedance of selenium (1.2-fold above standard, using refined concentration) water quality standards.

- Razorback Sucker – The Proposed Action would result in small amounts of mercury and selenium to razorback sucker tissue and result in small increases in water concentrations in its critical habitat in the Northeast and Southwest Gap Regions and the San Juan River. The Proposed Action contribution combined with baseline emissions would result in a minor effect on razorback sucker in the Southwest Gap Region and San Juan River, as indicated by an estimated injury effect of up to 1 adult in each of the study areas over the 2020 to 2074 time frame of the project. The impact on the species is considered to be minor because less than 1 percent of the minimum viable razorback sucker adult population within the Southwest Gap Region and San Juan River would be affected by the Proposed Action in combination with baseline fish tissue concentrations. There would be a negligible effect in the Northeast Gap Region from the project and baseline conditions because the baseline levels of mercury and selenium are below impact thresholds and the project contributes a negligible amount of mercury and selenium to this area. There would be a minor effect on the water element of critical habitat in the Southwest Gap Region and the San Juan River, based on exceedances of water quality standards. The critical habitat effect was based on the estimate that the water quality exceedance would be small in the Southwest Gap Region (2-fold above Navajo Nation selenium standard, using a refined concentration). Similarly, there would be a minor effect on critical habitat in the San Juan River. Although the conservative Navajo Nation mercury water quality standard was exceeded, no measured mercury surface water concentration (including the maximum) was in excess of the National Ambient Water Quality Criteria.
- Bluehead Sucker – Proposed Action emissions by themselves would result in a negligible risk to bluehead sucker in the Northeast Gap Region, Southwest Gap Region, and the San Juan River. There would be minor effect when the Proposed Action is combined with baseline fish tissue concentrations in the Southwest Gap Region and San Juan River. The impact on the species is considered to be minor because less than 1 percent of the adult population in these areas would be affected. The combined effect of the Proposed Action and baseline conditions in the Northeast Gap Region would be negligible, as summarized for razorback sucker.
- Flannelmouth Sucker – Proposed Action emissions by themselves would result in a negligible risk to flannelmouth sucker in Lake Powell, Northeast Gap Region, Southwest Gap Region, and the San Juan River. There would be minor effects on flannelmouth sucker in the Southwest Gap Region and the San Juan River, as discussed for razorback sucker. There would be negligible effects on this species in Lake Powell and the Northeast Gap Region, as summarized for the razorback sucker.
- Speckled Dace – The effects would be the same as summarized for bluehead sucker.
- Northern Leopard Frog – In terms of the analysis for the proposed KMC, there would be negligible effects of metals on northern leopard frog from NGS and KMC combined emissions. Groundwater pumping for the proposed KMC Proposed action would contribute less than 0.03 percent reduction in Begashibito Wash.
- Special Status Fish and Transmission Systems – The operation and maintenance of the transmission systems would result in no effects to special status species because vegetation management and stream disturbance would not occur in or near the stream crossings transmission lines being 300 to 400 feet above the streams. In addition, best management practices for operation and maintenance activities in combination with additional conservation measures would avoid effects to species and their habitat.

3.13.4.3.5 Cumulative Impacts

The cumulative effects study area is expanded to include cumulative sources in the Upper Colorado River Basin and the upstream portion of San Juan River to the Navajo Dam. Actions involving changes in flow and water quality changes in the Upper Colorado River Basin would be evident at the Colorado and Green River confluence, which is the upper portion of the Proposed Action study area. In addition, changes in flow and water quality in the upper portion of the San Juan River would be evident the

Farmington area, which is the upper portion of the Proposed Action in the San Juan River. The portion of the Colorado River below Glen Canyon Dam is extended downstream to the inflow to Lake Mead. The following discussion is divided into cumulative emissions and other cumulative actions for each of the federally listed species and other special status aquatic species.

The relative trace metals impact contributions from the Proposed Action, baseline, and other cumulative sources are discussed by species. Each species discussion is then followed by other cumulative actions that also could contribute additional effects.

3.13.4.3.5.1 Bonytail

Cumulative Emission Effects

The combination of NGS and associated facilities and the proposed KMC emission plus other cumulative deposition sources with baseline fish tissue concentrations showed maximum and refined tissue-based HQs of 2 and 1, respectively, for mercury, which indicates a potential risk to bonytail due to other cumulative emissions (**Appendix 3.13-B, Tables 1A** and **1B**). The potential injury on bonytail individuals is considered minor, although it cannot be quantified due to the low number of bonytail in the Northeast Gap Region. The refined fish tissue HQs for total selenium and arsenic cumulative emissions were less than 1 (0.2 and 0.04, respectively), which indicates negligible risk to bonytail from these metals. The project contribution to total cumulative fish tissue concentrations would be less than 0.2 percent for each of the metals. There would be a negligible effect on critical habitat because of no exceedance of the National Ambient Water Quality Criteria standards and only a slight exceedance of the conservative Utah standard for mercury.

Other Cumulative Sources

Climate change and water diversions in the Upper Colorado Basin would contribute additional effects to the bonytail and its critical habitat in the Northeast Gap Region. Currently, the magnitude of global climate change is such that its effect on freshwater fisheries and other aquatic species could easily be masked by or attributed to other anthropogenic causes such as overexploitation, deforestation, and land use (Ficke et al. 2007).

3.13.4.3.5.2 Colorado Pikeminnow

Cumulative Emission Effects

Northeast Gap Region

There would be negligible risk from mercury on Colorado pikeminnow and its critical habitat from the combination of NGS and associated facilities and other cumulative emission sources plus baseline fish tissue concentrations, because the mercury CBR HQ is 2 (maximum) and 1 (refined) (**Appendix 3.13-B, Tables 2A** and **2B**). The selenium and arsenic fish tissue analysis showed a negligible risk to Colorado pikeminnow, because the HQs were less than 1. The project contributions to total cumulative fish tissue concentrations would be less than 0.2 percent for each of the metals. There would be a negligible effect on critical habitat in the Northeast Gap Region because of no exceedance of the National Ambient Water Quality Criteria standards and only a slight exceedance of the conservative Utah standard for mercury.

San Juan River

Using measured Colorado pikeminnow data for mercury, the combination of baseline fish tissue concentrations with the contribution from NGS emissions plus other cumulative emission sources showed a maximum HQ of 2 and refined HQ of 1 (**Appendix 3.13-B, Tables 3A** and **3B**). Using surrogate tissue data for Colorado pikeminnow, the total cumulative HQs were 3 (maximum) and 2 (refined). These results indicate a potential risk to the species from total cumulative emissions

(**Appendix 3.13-B, Tables 4A** and **4B**). The effect was due to an equal contribution from baseline conditions and other cumulative source. The combination of NGS arsenic and selenium emissions with baseline fish tissue concentrations and other cumulative sources using modeled (surrogate) fish tissue data would result in a HQ less than 1, which indicates a negligible risk from arsenic or selenium on Colorado pikeminnow. The ERA also included an analysis using Colorado pikeminnow tissue data rather than surrogate fish tissue concentrations (Ramboll Environ 2016b). The results were similar to those noted using surrogate species, and generally showed lower HQs compared to the surrogate analysis. Use of species-specific tissue data is appropriate to give species-specific relevance to the results and reduce uncertainty. However, these data were based on stocked fish released to the river and may underestimate baseline tissue concentrations for wild (non-stocked) fish populations, as stocked fish are expected to have less exposure time to instream conditions compared to wild fish that have spent their entire life in the San Juan River. For this reason, baseline fish tissue concentrations assessed using surrogate fish species for Colorado pikeminnow may be of equal relevance to “frame” the potential risk outcome. A potential risk to Colorado pikeminnow from mercury was indicated in both the surrogate fish species and pikeminnow fish tissue analyses for total cumulative emissions. The project contributions to total cumulative fish tissue concentrations would be less than 0.1 percent for each of the metals.

Species Effects – When the small contribution from the Proposed Action is added to baseline fish tissue concentrations and other cumulative emission sources, there would be a minor effect of mercury on Colorado pikeminnow in the San Juan River (**Table 3.13-26**). The effect is considered to be minor, because the estimated number of individuals affected by total cumulative emissions would be within the natural population variability. The NGS effect from mercury would be less than 1 adult or subadult Colorado pikeminnow for any of the injury categories, which represents less than 1 to 33 percent of the total cumulative emission effect categories. The higher percentages occur when relatively low injury effects are estimated for total cumulative emissions. The NGS effect from mercury emissions and deposition on eggs and larvae would represent an even smaller percentage of the total cumulative emission effects (less than 0.2 percent for mercury). The effect of total selenium emissions on Colorado pikeminnow would be 3,020 adults over the timeframe of the project, which is considered a moderate effect on the population. The NGS effect from selenium on Colorado pikeminnow would represent a small percentage of the total cumulative emission effects (less than 0.3 percent for eggs and less than 0.1 percent for larvae and adults).

Table 3.13-26 Mercury and Selenium Injury Effects to Colorado Pikeminnow in the San Juan River, 2020 to 2074

Emission Sources	Life Stages[1] (number of individuals)						
	Eggs/ Embryos	Larvae	Adult Reproduction	Juveniles (<400 mm)	Adults (>400 mm)	Subadult Behavioral Injury	Adult Behavioral Injury
Mercury							
NGS	593	12	1	1	1	1	1
Total Cumulative	309,617	73,263	12	156	3	7,872	158
Selenium							
NGS	41,118	76	NA[2]	NA[2]	1	NA[2]	NA[2]
Total Cumulative	151,002,145	552,375	NA[2]	NA[2]	3,020	NA[2]	NA[2]

[1] Values less than 1 rounded to 1.

[2] NA = Toxicity literature is not available to provide an estimate for this category.

mm = millimeter.

Critical Habitat Effects – Cumulative emissions also would affect critical habitat for Colorado pikeminnow in the San Juan River. The combination of the Proposed Action and other cumulative emissions would result in refined mercury surface water concentrations below National Ambient Water Quality Criteria but would exceed the conservative Navajo Nation Surface Water Quality Standard for total (unfiltered) mercury (0.012 microgram per liter).

Other Cumulative Sources

Climate change, water use, urban development, and other human activities also would affect Colorado pikeminnow individuals and its critical habitat. These activities are discussed in the Four Corners Power Plant and Navajo Mine Energy Biological Opinion (USFWS 2015a), as summarized below.

Climate change may contribute to additional depletions to the San Juan River. The magnitude and timing of the depletions cannot be predicted with certainty at this time. Several studies project a decrease in stream flow from eight to 45 percent depending on the model used, the time frame, and the methods (Christensen and Lettenmaier 2007; Hoerling et al. 2013; Ray et al. 2008 as cited in USFWS 2015a; Seager et al. 2007; Udall 2007). Although the San Juan River was not modeled independent of the entire Colorado River basin in these studies, based on the projections of the Intergovernmental Panel on Climate Change (Christensen et al. 2007) for warmer temperatures and an increase in the frequency of hot extremes and heat waves, it is reasonable to expect that there will be a decrease in stream flow in the future. The analysis of Bluff river flow gaging data indicates an annual reduction of some 9,200 acre-feet per year as a long-term linearized trend in the San Juan River Basin. This pattern is consistent with the data for the Colorado River Basin; however, the reduction as a percent of the annual total is double that of the Colorado River (0.44 percent per year, versus 0.22 percent per year for the Colorado River). Although the year-to-year variability is substantial, the ongoing reduction in river flows at this site is clear. Changes in flow patterns or flow volumes could affect key biological activities such as fish spawning and early stage development of eggs and young fish, as well as increasing the colonization of non-native or invasive aquatic species (Garfin et al. 2013). Higher air temperatures also may increase the water temperatures preferred by pikeminnow, resulting in local range expansions. Higher water temperatures also could cause positive or negative changes in food supply for fish by affecting invertebrate development (Garfin et al. 2013).

Water Diversions – Cumulative water diversions would include coalbed methane development, irrigation/canal withdrawals, livestock grazing, and water use for urban development. Other foreseeable non-federal Colorado San Juan River drainage water storage projects (documented by applications to the Colorado State Engineer) include the Long Hollow Reservoir (proposed capacity of 5,300 acre-feet) and the Dry Gulch Water Storage Project (proposed capacity of 11,000 acre-feet). These projects could contribute to cumulative reductions in Navajo Reservoir River storage, which could influence the volume of water available for release for fish habitat maintenance purposes.

Human Activities – The increase in recreation activities involving fishing, boating, camping, and vehicle use would result in angling pressure, non-point pollution, fire threat, introduction of non-native fish species, and potential disturbance to native fishes.

Non-native Fish Threat – A future threat of non-native fish movement from Lake Powell could occur during wet years when the waterfall barrier is inundated. Striped bass, channel catfish, walleye, and other non-native fish species would move into to the San Juan River and compete with Colorado pikeminnow and razorback sucker for food sources and habitat.

The role of conservation measures proposed for Colorado pikeminnow is to offset impacts of the Proposed Action and enhance and assist in the recovery the species by addressing cumulative effects. Measures which apply to Colorado pikeminnow are listed below.

- FS-3 would augment wild populations of Colorado pikeminnow and razorback sucker by offsetting the low recruitment rates for these species in the San Juan River. This measure also would assist in improving the genetic diversity of the brood stock and numbers of Colorado pikeminnow that would be used in stocking efforts in the San Juan River including areas affected by the project, as well as in the Upper Colorado River.
- FS-4 would benefit Colorado pikeminnow by facilitating movement of wild, breeding adult Colorado pikeminnow that are otherwise unable to reach their spawning areas in most years due to the waterfall barrier on the San Juan River arm of Lake Powell.
- FS-5 would benefit Colorado pikeminnow by improving and creating habitats that currently do not exist in the San Juan River. The restored habitats would provide breeding and recruitment areas for Colorado pikeminnow and other federally listed and sensitive native fish species that currently do not exist, which would increase reproduction and the survival of eggs, larvae, and young.

3.13.4.3.5.3 Humpback Chub

Cumulative Emission Effects

Northeast Gap Region

There would be a potential risk from mercury on humpback chub from the combination NGS and associated facilities and other cumulative emission sources with baseline fish tissue concentrations, because the mercury fish tissue is the HQ is 1. Tissue and HQ values would be the same as shown in **Appendix 13.3-B**, **Tables 1A** and **1B**. The selenium fish tissue analysis indicated a negligible risk to humpback chub as indicated by a HQ less than 1. There would be a negligible effect on critical habitat in the Northeast Gap Region because of no exceedance of the National Ambient Water Quality Criteria and only a slight exceedance of the conservative Utah standard for mercury.

Southwest Gap Region

The combination of NGS and associated facilities and other cumulative emissions with baseline fish tissue concentrations showed maximum and refined HQs of 4 and 3, respectively, for mercury, which indicates a potential risk to humpback chub (**Appendix 13.3-B**, **Tables 5A** and **5B**). The effect is due to baseline conditions and other cumulative emission sources. The addition of NGS selenium emissions with other cumulative sources and baseline conditions showed a HQ of less than 1, which indicates a negligible risk to humpback chub from selenium. The project contribution to total cumulative fish concentrations would be less than 0.2 percent for mercury and selenium. It is important to note that the ERA analysis is most comparable to the USFWS injury effect quantification because both take into account baseline, Proposed Action, and cumulative effects.

Species Effects – When the small contribution from the NGS Proposed Action is added to baseline conditions and other cumulative emission sources, there would be a minor effect of mercury on humpback chub in the Southwest Gap Region. The effect is considered to be minor because number of individuals (3 adults and 331 subadults) potentially injured due to mercury is likely within the natural variability of the population. The estimated injury effects are provided in **Table 3.13-27**. The total cumulative effect would be up to 3 adults and 331 subadults for mercury. The estimated Proposed Action injury would be less than 0.1 percent of the total cumulative emission effect from mercury. Toxicity literature is not available to make an injury estimate to adult and juvenile humpback chub from selenium.

Critical Habitat Effects – Cumulative emissions also would affect critical habitat for humpback chub in the Southwest Gap Region. The combination of the Proposed Action and other cumulative emissions would result in refined selenium surface water concentrations that exceed the National Ambient Water Quality Criteria Water Quality Standard and Arizona Water Quality Standard during the period 2020 to 2074.

Table 3.13-27 Mercury and Selenium Injury Effects to Humpback Chub in the Southwest Gap Region, 2020 to 2074

Emission Sources	Life Stages[1] (number of individuals)						
	Eggs/ Embryos	Larvae	Adult Repro.	Juveniles Behavioral	Adults Behavioral	Subadult Survivor-ship	Adult Survivor-ship
Mercury							
NGS	325	4	1	1	1	1	1
Total Cumulative	73,676	876	ND[2]	331	3	8	1
Selenium							
NGS	76,621	2,238	22	NA[1]	NA[1]	NA[1]	NA[1]
Total Cumulative	55,534,425	974,894	16,662	NA[1]	NA[1]	NA[1]	NA[1]

[1] Toxicity literature is not available to provide an estimate for this category.

mm = millimeter.

Other Cumulative Sources

Climate change, water use, urban development, mining, and other human activities would affect humpback chub and its critical habitat in the Gap Regions. These activities are discussed in the Glen Canyon Dam Long-term Experimental and Management Plan (Reclamation and NPS 2015), as summarized below.

Climate Change – Based on the SECURE Water Act Report (Reclamation 2016) and Reclamation and NPS (2015), climate changes in the Colorado River Basin include the following:

- Colorado River Basin temperature is projected to increase by an average of 5 to 6ºF during the 21st Century;
- Precipitation is expected to increase by 2.1 percent in the upper basin and decline by 1.6 percent in the lower basin;
- Mean annual runoff is projected to decrease by 3.5 to 8.5 percent by 2050;
- Warmer conditions might cause changes in fisheries habitat, shifts in species geographic ranges, increased water demands for instream ecosystems and thermoelectric power production, increased power demands for municipal uses (including cooling) and increased likelihood of invasive species infestations. Endangered species issues might be exacerbated although warmer water may increase spawning success for native species; and
- Increases in the water temperature of Colorado River mainstem and its tributaries in Grand Canyon due to climate change could expand the distribution of warmwater-adapted non-native fishes (Eaton and Scheller 1996; Rahel and Olden 2008), which can prey on and compete with native fishes such as endangered humpback chub or disadvantaged coldwater non-native species.

Water Use and Diversions – Other private water diversions in the Upper Colorado River Basin likely would occur in the future, although the total water diversions are not known at this time. These future water diversions would contribute new depletions to the Upper Colorado River Basin, which would reduce flows into Lake Powell. However, flow releases from Lake Powell would follow the future long-term operation and management plan, which is being evaluated in an EIS (Reclamation and NPS 2015).

Mining – Based on a renewed interest in uranium, there could be increased mining on lands that drain into the Colorado River, which could increase the amount of uranium, arsenic, and other trace elements in local surface water and groundwater. Aquatic species and habitat most likely to be affected by mining would be those associated with small ephemeral and intermittent streams. A spill of uranium ore or other mining material that reached a perennial stream could affect water quality in the Colorado River. However, the timing and extent of such an accidental spill is unpredictable, and spill control and containment requirements would likely minimize any long-term effect on fish species or their habitat.

Human Activities – Increased human activities in the Colorado River below Glen Canyon Dam to Lake Mead. Although urban runoff, industrial releases, and municipal discharges are considered some of the leading nonpoint sources of contaminants to surface waters, the 2007 Reclamation Interim Guidelines have improved water supply conditions through increased water conservation efforts, which in turn are providing more predictability in water supply to users in the Basin States (especially the Lower Basin). Although fishing pressure and recreational activities would likely increase in the future, the Comprehensive Fisheries Management Plan and the Non-native Fish Control Program would protect and benefit recreational fishing below Glen Canyon Dam.

The role of conservation measures proposed for humpback chub is to offset impacts of the Proposed Action and enhance and assist in the recovery the species by addressing cumulative effects. The following measures apply to humpback chub:

The control of nonnative fish in the Grand Canyon portion of the Colorado River would reduce predation on humpback chub and razorback sucker. The measure would help protect the entire mainstem Colorado River from Lees Ferry to the inflow to Lake Mead. The specific level of benefit to this reach will be determined from a qualitative analysis of the number of nonnative fish removed and relative reduction in nonnative fish predation in the area that is treated.

3.13.4.3.5.4 Razorback Sucker

Cumulative Emission Effects

Northeast Gap Region

The combination of NGS and associated facilities and other cumulative emissions with baseline fish tissue concentrations showed maximum and refined HQs of 2 and 1, respectively, which indicates a potential risk to razorback sucker from mercury due to other cumulative emissions. Tissue and HQ values would be the same as shown in **Appendix 3.13-B**, **Tables 1A** and **1B**. There would be a negligible risk from selenium on razorback sucker from future NGS and other cumulative sources in the Northeast Gap Region because HQs were less than 1. The project contribution to total cumulative fish tissue concentrations would be less than 0.2 percent. There would be a negligible effect on critical habitat in the Northeast Gap Region because of no exceedance of the National Ambient Water Quality Criteria and only a slight exceedance of the conservative Utah standard for mercury.

Southwest Gap Region

The combination of the NGS Proposed Action and other cumulative emissions with baseline fish tissue concentrations showed mercury HQs of 8 (maximum) and 5 (refined) using the flannelmouth sucker as a surrogate and 5 (maximum) and 3 (refined) based on the surrogate, bluehead sucker (**Appendix 3.13-B**, **Tables 6A** and **6B**). Both HQs indicate a potential risk to razorback sucker, which is mainly due to baseline conditions and other cumulative emission sources. The NGS contribution to selenium concentrations in the Southwest Gap Region also is very small, with a tissue-based refined HQ of 0.0003. The addition of NGS selenium emissions with other cumulative sources showed refined HQs of 1 (maximum and refined for flannelmouth sucker surrogate) and 0.7 (maximum and refined for bluehead sucker surrogate). Based on the flannelmouth sucker HQ, there is a potential risk from selenium on razorback sucker due to baseline fish tissue concentrations. The project contribution to total cumulative fish tissue concentrations in the Southwest Gap Region would be less than 0.2 percent. It is important to note that the ERA analysis is most comparable to the USFWS injury effect quantification because both take into account baseline, Proposed Action, and cumulative effects.

San Juan River

The combination of the NGS Proposed Action and other cumulative emissions with baseline fish tissue concentrations indicated a negligible risk to razorback sucker from mercury and selenium. Mercury maximum and refined HQs were 2 and 0.8, respectively, using the flannelmouth sucker as a surrogate and 0.7 and 0.5, respectively, based on the surrogate, bluehead sucker (**Appendix 3.13-B**, **Tables 7A** and **7B**). Selenium refined HQs were 1 (maximum) and 0.4 (refined) for flannelmouth sucker and 0.8 (maximum) and 0.3 (refined) for bluehead sucker. HQ values below 1 indicate that the risk of effect from total cumulative emissions on razorback sucker in the San Juan River would be negligible. Similarly, low refined HQs were shown for arsenic (0.02 for the flannelmouth sucker surrogate and 0.04 for the bluehead sucker surrogate). Maximum HQs for stocked razorback sucker were 1 for mercury and selenium, and <0.1 for arsenic, while refined HQs were 0.7 for mercury, 0.5 for selenium, and <0.1 for arsenic (**Appendix 3.13-B**, **Tables 8A** and **8B**). As mentioned above for Colorado pikeminnow, HQs based on surrogate fish species were used as a more conservative indicator of cumulative effects to frame the risk results. The project contribution to total cumulative fish tissue concentrations would be less than 0.1 percent for both the species-specific and surrogate analyses. Although the HQs indicated a low risk level, an injury effect was determined based on toxicity data as discussed below.

Species Effects – Based on population and toxicity data, the injury effects were estimated for razorback sucker in the Southwest Gap Region and San Juan River by the USFWS methodology (**Tables 3.13-28** and **3.13-29**, respectively). The effect is considered to be moderate because the number of individuals potentially injured (i.e., 2,653 in the Southwest Gap Region due to mercury and 3,085 and 15,182 adults in the San Juan River due to mercury and selenium, respectively) is likely outside of the natural variability of the population. The methodology used in the injury effects analysis is provided in **Appendix 3.13-A.** The total cumulative effect in the Southwest Gap Region would be up to 4 adults for mercury. The estimated Proposed Action injury would be less than 0.1 percent of the total cumulative emission effect from mercury in the Southwest Gap Region and from mercury and selenium in the San Juan River. Toxicity literature is not available to make an injury estimate to adult razorback sucker from selenium in the Southwest Gap Region. The effect quantification for the federally listed fish species was a separate analysis that provided an estimate of the number of individuals by life stage that could be affected by project emissions and deposition. The effect analysis also provides a separate line of evidence (i.e., compared to the ERAs) as to whether the listed fish would be affected by the project. It is a separate analysis compared to the ERAs, which identified potential risk of effects to species. The ERA results were helpful in determining whether an injury effect should be completed. However, the ERAs do not quantify the effect on individuals. Both analyses used some of the same toxicity information such as threshold effect levels for mercury and selenium. However, the effect quantification applied toxicity information to population and life stage numbers to provide an estimate of individuals affected.

Table 3.13-28 Mercury and Selenium Injury Effects to Razorback Sucker in the Southwest Gap Region, 2020 to 2074

Emission Sources	Life Stages[1] (number of individuals)						
	Eggs/ Embryos	**Larvae**	**Adult Repro.**	**Juveniles Behavioral**	**Adults Behavioral**	**Subadult Survivorship**	**Adult Survivorship**
Mercury							
NGS	45	1	1	1	1	1	1
Total Cumulative	10,212	162	1	10	4	3	2
Selenium							
NGS	21,611	1,259	1	NA[1]	NA[1]	NA[1]	NA[1]
Total Cumulative	723,936	548,519	295	NA[1]	NA[1]	NA[1]	NA[1]

[1] Toxicity literature is not available to provide an estimate for this category.

Table 3.13-29 Mercury and Selenium Injury Effects to Razorback Sucker in the San Juan River, 2020 to 2074

Emission Sources	Life Stages[1] (number of individuals)						
	Eggs/ Embryos	**Larvae**	**Adult Reprodu ction**	**Juveniles**	**Adults**	**Subadult Behavioral Injury**	**Adult Behavioral Injury**
Mercury							
NGS	4,510	72	1	5	2	1	1
Total Cumulative	9,282,671	148,042	286	9,137	3,085	224	1,084
Selenium							
NGS	485,154	301	NA[1]	NA[1]	7	NA[1]	NA[1]
Total Cumulative	1,176,895,548	3,915,091	NA	NA[1]	15,282	NA[1]	NA[1]

[1] Toxicity literature is not available to provide an estimate for this category.

Critical Habitat Effects – Based on the USFWS methodology, total cumulative emissions and deposition could result in a minor effect on the primary constituent water element of critical habitat for razorback sucker in the Southwest Gap Region and San Juan River, because surface water concentrations exceeded water quality standards for mercury and selenium. The effect is considered minor because the percent of critical habitat potentially affected would be approximately 4 percent in the Southwest Gap Region and 12 percent in the San Juan River. In addition, the estimated surface water concentrations using refined values only slightly exceeded the water quality standards.

Other Cumulative Sources

Other cumulative actions that would adversely affect razorback sucker individuals and its critical habitat in the San Juan River and Southwest Gap Region include climate change, water use, urban development, mining, and other human activities such as recreation. These activities and effects on razorback sucker would be the same as discussed for the Colorado pikeminnow for the San Juan River and humpback chub for the Southwest Gap Region.

The role of conservation measures proposed for razorback sucker is to offset impacts of the Proposed Action and enhance and assist in the recovery the species by addressing cumulative effects. Measures which apply to razorback sucker are listed below.

- FS-1 would involve the control of nonnative fish in the Grand Canyon portion of the Colorado River would reduce predation on humpback chub and razorback sucker. The measure would help protect the entire mainstem Colorado River from Lees Ferry to the inflow to Lake Mead. The specific level of benefit to this reach will be determined from a qualitative analysis of the number of nonnative fish removed and relative reduction in nonnative fish predation in the area that is treated.
- FS-2 would augment razorback sucker numbers in the Grand Canyon portion of the Colorado River through translocations, if the NPS determines that the species needs augmentation. If translocations are determined by NPS to be needed, this measure will offset Project-related impacts to razorback sucker by increasing razorback sucker numbers in the Grand Canyon.
- FS-3 would augment wild populations of Colorado pikeminnow and razorback sucker by offsetting the low recruitment rates for these species in the San Juan River. This measure also would assist in improving the genetic diversity of the brood stock and numbers of Colorado pikeminnow that would be used in stocking efforts in the San Juan River including areas affected by the project, as well as in the Upper Colorado River.
- FS-4 would involve provide financial support to capture and transport Colorado pikeminnow and razorback sucker upstream of a waterfall and allow access to habitat in the San Juan River. Funding to support the capture and transportation of these fish around this barrier would offset the effects of mercury by increasing the number of potentially spawning fish in the San Juan River and serve as a mechanism to connect the river and lake below the waterfall with fish and habitat in the river upstream of the barrier.
- FS-5 would provide funding to improve and provide habitat for Colorado pikeminnow and razorback sucker in the San Juan River, which could be used for nursery or recruitment areas for these species. This measure will offset project-related impacts to Colorado pikeminnow and razorback sucker by providing habitat that currently does not exist in the San Juan River, which will improve species recruitment.

3.13.4.3.5.5 Northern Leopard Frog

Cumulative Emission Effects

The NGS 3-Unit Operation and 2-Unit Operation would contribute very small concentrations to the baseline conditions and other cumulative sources. The 2-Unit Operation would reduce mercury and selenium levels by approximately 35 percent. There would be negligible effects of metals on northern leopard frog from overall cumulative emissions.

Other Cumulative Sources

Groundwater pumping for the proposed KMC Proposed action would contribute less than 0.03 percent reduction in Begashibito Wash. Other cumulative pumping (communities) would reduce flow in Begashibito Wash by approximately 18 percent of 2020 rates, which is a substantial reduction in habitat. This reduction level would remove potential habitat for northern leopard frog, which is considered to be potential breeding habitat.

3.13.4.3.5.6 Desert Pupfish, Gila Chub, Gila Topminnow, Loach Minnow, Spikedace, and Roundtail Chub

Other Cumulative Effects

The NGS Proposed Action effects would combine with other cumulative actions at a few locations within the transmission line ROWs where special status species are present. These cumulative actions include road use and recreation activities. Streams that overlap with other cumulative actions include the Verde and Aqua Fria rivers for the STS. Relatively few factors affect fish habitat at the Verde River crossing in comparison to the Agua Fria crossing, because it is located in closer proximity to human development. Therefore, the Agua Fria crossing is at greater risk of cumulative effects from recreation within riparian corridors; livestock grazing; road construction, use, and maintenance; and environmental contaminants. The total cumulative impact on special status species in these streams would be considered negligible based on effects from other cumulative activities. However, there would be no effects to these fish species due to the project.

3.13.4.3.5.7 Virgin River Chub and Woundfin

Other Cumulative Effects

The NGS Proposed Action effects would combine with other cumulative actions at a few locations within the transmission line ROWs where special status species are present. These cumulative actions include road use and recreation activities and the TransWest Express Transmission Project, Southern Nevada Intertie project, and the Lake Powell Pipeline for the WTS. Streams that overlap with other cumulative actions include Meadow Valley Wash and Muddy River for the WTS. Project activities in the Virgin and Muddy river drainages would result in no effects on Virgin River chub and woundfin. Vehicle use from overall cumulative activities poses some risk of fuel spills on Virgin and Muddy rivers occupied and critical habitat areas. The total cumulative impact on special status species would be low based on other cumulative activities for these areas.

3.13.4.4 Natural Gas Partial Federal Replacement Alternative

This discussion focuses on the impacts to aquatic species from reducing the power generated at NGS, with consequent reductions in coal production at the Kayenta Mine. There is limited discussion of the alternative site because it is assumed that surface water and perennial waterbodies would be limited when considering the arid characteristics of region.

Site Characteristics and Resource Impacts

Under the Natural Gas PFR Alternative, a selected quantity of power between 100 megawatts (MW) and 250 MW would be contracted for under a long-term power purchase agreement from currently unidentified, existing natural gas generation sources, displacing an equivalent amount of power from the federal share of NGS generation. Key assumptions about aquatic biological resources related to such an existing site are listed below.

- A combined-cycle natural gas power plant typically would be located on a site of approximately 100 acres. No additional surface disturbance would be required over time.
- Potential surface disturbance could occur at scattered locations within the entire site.
- Perennial waterbodies are assumed to be limited within the alternative site due to the arid characteristics of the general region.
- Natural gas combustion for power generation would not result in COPECs emissions and deposition that would overlap with the coal combustion emissions and deposition from NGS; therefore, there would be no deposition from natural gas combustion to surface water in the

study area. The description of emission calculations for the PFR is described in Chapter 2.0 and Section 3.1, Air Quality.

- An existing gas plant would have been permitted by USEPA to operate and thus meet all air quality standards protective of environment including aquatic species.
- Because the Proposed Action results for the 2,250-MW coal plant emissions impacts are very small/negligible for aquatic species, and that the anticipated emissions from NGCC plant (see Section 3.1 appendices) would be a fraction of NGS emissions, then the impacts would likely be negligible as well.

Impact issues for this PFR Alternative are discussed across the range of NGS operations and associated alternative power reductions (100 MW and 250 MW) from the least NGS power reduction to the greatest. Reductions in NGS power generation would proportionally reduce the quantity of coal delivered from the Kayenta Mine. The focus of this discussion is to distinguish differences in impacts within the replacement alternative operational range to provide a basis for comparison with the Proposed Action.

3.13.4.4.1 Navajo Generating Station

The Natural Gas PFR Alternative would result in the following percent reductions in power output for the 100-MW and 250-MW replacements in comparison to the Proposed Action: 5 and 13 percent for the 3-Unit Operation and 8 and 19 percent for the 2-Unit Operation. The reduction in power output would result in less coal burned and lower deposition of metals and other COPECs in the portions of the study area analyzed for NGS and associated facilities (i.e., NGS Near-field, Northeast Gap Region of the Colorado River, Southwest Gap Region of the Colorado River, and the San Juan River) when compared to the Proposed Action. As a result of lower deposition of metals, the risk indicator or HQ for special status aquatic species would be slightly reduced in each of the study areas. For example, a comparison of the mercury HQs for the Proposed Action and a modeled 1,400-MW scenario using ERA analyses (Ramboll Environ 2016c) showed a very small reduction in adult sport fish HQ values (**Table 3.13-30**). The 1,400-MW scenario was modeled for the ERA to depict a data point between the values presented for the smallest change (3-Unit Operation/100-MW Replacement) and largest change (2-Unit Operation and 250-MW Replacement). A similarly slight reduction is shown for selenium. The point of this comparison is to show that there would be a very slight reduction in risk to special status aquatic species from mercury or selenium under this alternative for both the 3-Unit Operation and 2-Unit Operation. The difference in risk resulting from this Natural Gas PFR Alternative would negligible as compared to the 3-Unit Operation and 2-Unit Operation, and the effects are therefore practicably (albeit very slightly less) the same as discussed for the Proposed Action.

Table 3.13-30 Comparison of Mercury HQs for the Proposed Action and Natural Gas PFR Alternative

ERA Analysis Areas / Species	Proposed Action 3-Unit Operation (Refined – Maximum)	Proposed Action 2-Unit Operation (Refined – Maximum)	1,400-MW ERA-modeled Scenario (Refined – Maximum) *
Northeast Gap			
Bonytail, Colorado pikeminnow, humpback chub, razorback sucker	0.002 – 0.003	0.001 – 0.003	0.0007 – 0.001
Southwest Gap			
Humpback chub	0.003 – 0.005	0.002 – 0.005	0.001 – 0.002
Razorback sucker	0.003 – 0.005	0.002 – 0.005	0.001 – 0.002

Table 3.13-30 Comparison of Mercury HQs for the Proposed Action and Natural Gas PFR Alternative

ERA Analysis Areas / Species	Proposed Action 3-Unit Operation (Refined – Maximum)	Proposed Action 2-Unit Operation (Refined – Maximum)	1,400-MW ERA-modeled Scenario (Refined – Maximum) *
San Juan River			
Colorado pikeminnow	0.0008 – 0.001	<0.0008 – <0.001	<0.0008 – <0.001
Razorback sucker	0.0004	<0.0004	<0.0004

* Source: Ramboll Environ (2016b,c) ERAs.

The combination of this PFR Alternative with baseline conditions would represent potential risks to several special status aquatic species in the San Juan River and Southwest Gap Region of the Colorado River, because refined HQs are greater than 1. The potential risk is dictated by baseline fish tissue concentrations for mercury and selenium rather than the project contribution under the PFR Alternative. Species that would be affected include the federally listed species, Colorado pikeminnow, humpback chub, and razorback sucker, and other special status species such as flannelmouth sucker, bluehead sucker, and speckled dace. The impact level would be considered minor, because the injury effect or potential loss of individuals from mercury or selenium tissue concentrations would be small and within the natural population variability over the 2020 to 2074 timeframe of the project.

There would be a potential minor effect on critical habitat for Colorado pikeminnow and razorback sucker in the San Juan River and humpback chub and razorback sucker in the Southwest Gap Region of the Colorado River. The effect on critical habitat is based on an exceedance of the conservative Navajo Nation water quality standard for mercury in the San Juan River, and the Navajo Nation standard for selenium in the Southwest Gap area of the Colorado River.

The following risks and effects would occur for the federally listed fish and other special status species as a result of Natural Gas PFR Alternative. It is important to mention that emissions and deposition from the Natural Gas PFR Alternative by itself would represent a negligible risk to the species and their critical habitat, based on the very small HQs. Potential risks and effects to species from the combination of the Natural Gas PFR Alternative with baseline fish tissue concentrations are summarized below.

3.13.4.4.1.1 Bonytail

Risks from NGS emissions and deposition would be negligible in the Northeast Gap Region, because HQs would be less than 1. There would be a negligible effect on bonytail, because injury or loss of individuals would not be detectable. There would be a negligible effect on critical habitat in the Northeast Gap Region because refined mercury concentrations exceeded water quality standards.

3.13.4.4.1.2 Colorado Pikeminnow

Risks and effects from NGS emissions and deposition in combination with baseline fish tissue concentrations would be the same as described for bonytail. There would be negligible effects on Colorado pikeminnow and its critical habitat in the Northeast Gap Region. There would be a negligible risk to this species from selenium. There would be a potential risk from mercury in the San Juan River due to the HQ exceeding 1 for this alternative in combination with baseline fish tissue concentrations. There would be a potential small loss of individuals in the San Juan River, which would be a minor effect because less than 1 percent of the current Colorado pikeminnow population would be affected. Based on the USFWS methodology, there would be a minor effect on critical habitat for this species in the San Juan River, because the exceedance of the conservative Navajo Nation water quality standard for mercury was small. National Ambient Water Quality Criteria were not exceeded. Conservation measures FS-3 (Support Activities at the USFWS Southwest Research and Recovery Center), FS-4 (Support

Transport of Colorado pikeminnow and Razorback Sucker above the Waterfall Barrier), and FS-5 (Funding Support for a Habitat Enhancement Project in the San Juan River) would be implemented to offset impacts to Colorado pikeminnow from the PFR alternative plus cumulative emission sources.

3.13.4.4.1.3 Humpback Chub

Risks and effects from NGS emissions and deposition in combination with baseline fish tissue concentrations would be the same as described for bonytail. There would be negligible effects on humpback chub and its critical habitat in the Northeast Gap Region due to slight exceedance of Utah water quality standard. There would be a negligible risk from mercury and selenium in the Southwest Gap Region, as indicated by HQs less than 1 for this alternative in combination with baseline fish tissue concentrations. By applying the USFWS injury effect analysis for the Proposed Action to the PFR Alternative, there would be a potential small loss of individuals in the Southwest Gap Region, which would be a minor effect because less than 1 percent of the current humpback chub population. There would be a minor effect on critical habitat for this species in the San Juan River, because the exceedance of the conservative Navajo Nation water quality standard for mercury was small. National Ambient Water Quality Criteria were not exceeded. Conservation measures FS -1 (Non-native Fish Management in the Colorado River Grand Canyon Area) would be implemented to offset impacts to humpback chub from the PFR Alternative plus cumulative emission sources.

3.13.4.4.1.4 Razorback Sucker

Risks and effects from NGS emissions and deposition in combination with baseline fish tissue concentrations would be the same as described for bonytail. There would be negligible effects on razorback sucker and its critical habitat in the Northeast Gap Region. There would be a potential risk from mercury and selenium in the Southwest Gap Region due to the HQ exceeding 1 for this alternative in combination with baseline fish tissue concentrations. There would be a negligible risk from mercury and selenium in the San Juan River, as indicated by HQs less than 1 for this alternative in combination with baseline fish tissue concentrations. There would be a potential small loss of individuals in the Southwest Gap Region and San Juan River, which would be a minor effect because less than 1 percent of the minimum viable razorback sucker population would be affected. There would be a minor effect on critical habitat for this species in the Southwest Gap Region and the San Juan River, because the exceedance of the conservative Navajo Nation water quality standard for mercury was small. National Ambient Water Quality Criteria were not exceeded. Conservation measures FS-1 (Non-native Fish Management in the Colorado River Grand Canyon Area) and FS-2 (Razorback Sucker Translocations) would be implemented to offset impacts to razorback sucker from the PFR Alternative plus cumulative emission sources.

Other Special Status Species – Risks and effects on flannelmouth sucker, bluehead sucker, and speckled dace would occur in the Southwest Gap Region and the San Juan River. There would be potential risks to these species in both study areas, as well as minor effects on the species. The effects are considered minor because potential loss of individuals would comprise less than 1 percent of their overall populations.

3.13.4.4.2 Proposed Kayenta Mine Complex

The following discusses the impacts to aquatic biological resources if 100 MW to 250 MW of power generation were replaced at NGS by alternative sources and the proposed KMC would mine less coal (8.1 million tons per year [tpy] production for the NGS 3-Unit Operation and 5.5 million tpy production for the NGS 2-Unit Operation. Under the Renewable PFR, alternative power would be purchased by Reclamation from an unknown, but existing source. Therefore, prior disturbance impacts to aquatic biological resources are not evaluated.

3.13.4.4.2.1 Mine Emissions and Deposition

The Natural Gas PFR Alternative would result in the same level of effect on the northern leopard frog, which is the only special status aquatic species within the proposed KMC. This alternative would not disturb northern leopard frog habitat, because no habitat is located within the mining areas or road realignment area. Proposed KMC emissions and metal concentrations would be slightly less than the Proposed Action for both the 8.1-million tpy and 5.5-million tpy production levels associated with the 3-Unit Operation and 2-Unit Operation. There would be negligible risks to northern leopard frog due to metal concentrations, as indicated by a HQ less than 1. The impact level would be considered negligible for northern leopard frog in relation to both coal production levels.

3.13.4.4.2.2 Groundwater Pumping

Groundwater pumping would be the same as the Proposed Action, with less than 1 percent potential reduction in stream and spring flows. This small change would represent a negligible effect to northern leopard frog habitat.

3.13.4.4.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

There would be negligible impacts to the exiting transmission systems and communication sites because no changes in the operations of the WTS, STS, or communications sites would occur due to the implementation of the Natural Gas PFR Alternative. Impacts would be negligible to special status fish species that occur in streams crossed by the WTS and STS, as described for the Proposed Action. Best management practices and applicant-committed protection measures would be implemented to reduce impacts to a negligible level for special status fish species.

3.13.4.4.4 Project Impact Summary

In summary, the Natural Gas PFR Alternative would result in 5 to 19 percent power reduction at NGS compared to the Proposed Action, which would result in lower emissions and deposition of metals within the study area. As a result of lower deposition of metals, the risk indicator or HQ for special status aquatic species would be slightly reduced in each of the study areas compared to the Proposed Action. NGS emissions under this alternative by themselves represent a negligible risk on all species, as indicated by the very small HQ values. The combination of NGS emissions and baseline conditions would result in potential risks to Colorado pikeminnow in the San Juan River and razorback sucker in the Southwest Gap Region. Effects on all special status species in the Northeast Gap Region would be negligible, as indicated by the HQs being less than 1 for NGS and baseline emissions. The effects of the Natural Gas PFR Alternative on special status aquatic species were considered minor based on the low number of fish that could be injured and the small percentage of fish population numbers potentially affected. In addition, there would be minor effects on critical habitat for Colorado pikeminnow and razorback sucker in the San Juan River and humpback chub and razorback sucker and Colorado pikeminnow in the Southwest Gap Region, because the level of exceedance of water quality standards for mercury and selenium was small. The implementation of conservation measures for the San Juan River and the Colorado River below Glen Canyon Dam would be used to benefit the species.

In terms of the analysis for the proposed KMC, there would be negligible effects from metals on northern leopard frog from overall cumulative emissions. Groundwater pumping for the proposed KMC Proposed action would contribute 0.03 percent reduction in flow in Begashibito Wash.

The operation and maintenance of the transmission systems would result in minor effects on special status species, because access road use and potential vegetation treatment would be short-term in duration and limited in terms of surface disturbance. By following best management practices for operation and maintenance activities in combination with additional conservation measures, effects on species and their habitat would be minimized.

3.13.4.4.5 Cumulative Impacts

The combination of NGS and proposed KMC emissions under the Natural Gas PFR Alternative plus other cumulative deposition sources would result in the same total cumulative emission effects as described previously for the Proposed Action. The only difference is that the NGS contribution to total cumulative emissions would be slightly less compared to the Proposed Action, as indicated by slightly lower HQs. However, the project risk and contribution is so small that it does not change the overall effects to special status species. The effects on the special status aquatic species are dictated by baseline fish tissue concentrations and deposition from other cumulative sources. A summary of the total cumulative emission effects to species is provided below.

- Bonytail – There would be a potential risk to bonytail from mercury in the Northeast Gap Region as indicated by a HQ of 1. The potential injury to the species is not quantifiable due to the low number of bonytail in the Northeast Gap Region. There would be a negligible effect on critical habitat for bonytail in the Northeast Gap Region. Although the conservative Utah water quality standard for mercury was exceeded, no measured surface water concentration was in excess of the National Ambient Water Quality Criteria.
- Colorado Pikeminnow – There would be a potential risk from mercury in the Northeast Gap Region. Species effects would be minor, as described for bonytail. There also would be a potential risk from mercury in the San Juan River, as indicated by a HQ of 2. Species effects would be minor, because the small number of adults that could be affected is within the natural population variability. There would be a minor effect on critical habitat for Colorado pikeminnow in the San Juan River. Although the conservative Navajo Nation water quality standard for mercury was exceeded, no measured surface water concentration was in excess of the National Ambient Water Quality Criteria.
- Humpback Chub – There would be a potential risk from mercury in the Northeast Gap Region. Species effects would be minor, as described for bonytail. There also would be a potential risk from mercury in the Southwest Gap Region, as indicated by a HQ of 3. Species effects would be moderate, because the number of adults that could be affected is likely outside the natural variability of the species. There would be a minor effect on critical habitat for humpback chub in the Southwest Gap Region. Although the conservative Navajo Nation water quality standard for mercury was exceeded, no measured surface water concentration was in excess of the National Ambient Water Quality Criteria.
- Razorback Sucker – There would be a potential risk from mercury in the Northeast Gap Region. Species effects would be minor, as described for bonytail. There would be potential risks from mercury and selenium in the Southwest Gap Region as indicated by HQs of 3 and 5. The ERA analysis indicated a negligible risk from mercury and selenium. Species effects would be moderate, because the number of adults that could be affected is likely outside the natural variability of the species. There would be a minor effect on critical habitat for razorback sucker in the San Juan River and Southwest Gap Region. Although the conservative Navajo Nation water quality standard for mercury was exceeded, no measured surface water concentration was in excess of the National Ambient Water Quality Criteria. Similar results were found for selenium.

Other cumulative actions that would adversely affect special status aquatic species and their habitat in the San Juan River, Northeast Gap Region, and Southwest Gap Region include climate change, water use, urban development, mining, and other human activities such as recreation. These activities and effects on razorback sucker would be the same as discussed in the Proposed Action cumulative impact discussions for the Colorado pikeminnow for the San Juan River and humpback chub for the Southwest Gap Region.

Cumulative effects of the Natural Gas PFR Alternative in combination with other cumulative actions in the proposed KMC and transmission system areas would be the same as discussed in the Proposed Action cumulative impacts section.

3.13.4.5 Renewable Partial Federal Replacement Alternative

Under the Renewable PFR Alternative, a selected quantity of power between 100 MW and 250 MW would be contracted for under a long-term power purchase agreement from a currently unidentified, existing renewable energy power source, displacing an equivalent amount of power from the federal share of NGS generation. Therefore, prior disturbance impacts to special status aquatic species are not evaluated.

3.13.4.5.1 Navajo Generating Station

The Renewable PFR Alternative would result in the following percent reductions in power output for the 100-MW and 250-MW replacements in comparison to the Proposed Action: 3 and 7 percent for the 3-Unit Operation and 4 and 11 percent for the 2-Unit Operation. The reduction in power output would result in less coal burned and lower deposition of metals and other COPECs in the portions of the study area analyzed for NGS and associated facilities (i.e., NGS Near-field, Northeast Gap Region of the Colorado River, Southwest Gap Region of the Colorado River, and the San Juan River) when compared to the Proposed Action. As a result of lower deposition of metals, the risk indicator or HQ for special status aquatic species would be slightly reduced in each of the study areas compared to the Proposed Action. Although there is a slight reduction in Project risks from mercury and selenium, the combination of Renewable PFR Alternative with baseline fish tissue concentration would represent the same risks and effects as discussed for the Proposed Action and the Natural Gas PFR Alternative.

3.13.4.5.2 Proposed Kayenta Mine Complex

The effects of the Renewable PFR Alternative from emissions and groundwater pumping on northern leopard would be the same as described for the Proposed Action and the Natural Gas PFR Alternative. There would be negligible effects on northern leopard frog proposed KMC emissions and groundwater pumping in relation to the 8.1 million tpy (3-Unit Operation) and 5.5 million tpy (2-Unit Operation) coal production operations.

3.13.4.5.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

There would be no changes in the operations of the WTS, STS, or communications sites if the Natural Gas PFR Alternative were implemented. Impacts would be negligible to special status fish species that occur in streams crossed by the WTS and STS, as described for the Proposed Action. Best management practices and applicant-committed protection measures would be implemented to reduce impacts to a negligible level for special status fish species.

3.13.4.5.4 Project Impact Summary – All Project Components

In summary, the Renewable PFR Alternative would result in 3 to 11 percent power reduction at NGS compared to the Proposed Action, which would result in lower emissions and deposition of metals within the study area. As a result of lower deposition of metals, the risk indicator or HQ for special status aquatic species would be slightly reduced in each of the study areas compared to the Proposed Action. NGS emissions under this alternative by themselves represent a negligible risk on all species, as indicated by the very small HQ values. The effects of the Renewable PFR Alternative in combination with baseline fish tissue concentrations would be the same as described for the Proposed Action and the

Natural Gas PFR Alternative. The reason for same effects is that the baseline fish concentrations dictate the risks for special status aquatic species in all portions of the study area.

3.13.4.5.5 Cumulative Impacts

The combination of NGS and proposed KMC emissions under the Renewable PFR Alternative plus other cumulative deposition sources would result in the same total cumulative emission effects as described for the Proposed Action. The only difference is that the NGS contribution to total cumulative emissions would be slightly less compared to the Proposed Action, as indicated by slightly lower HQs. However, the project risk and contribution is so small that it does not change the overall effects to special status species.

3.13.4.6 Tribal Partial Federal Replacement Alternative

Under the Tribal PFR Alternative, between 100 MW and 250 MW of power generation from the NGS would be replaced by power supplied by a new photovoltaic generation facility on tribal land, displacing an equivalent amount of power from the federal share of NGS generation. The construction of a new photovoltaic generation site on tribal land would result in between 1,200 and 3,000 acres of new surface disturbance. The Tribal PFR facility would be analyzed in a separate National Environmental Policy Act process once a facility location is identified. When considering the general conditions of tribal lands that could be used, it is assumed that site would be dry with no perennial water. For this reason, there would be no effect on special status aquatic species.

3.13.4.6.1 Navajo Generating Station

The Tribal PFR Alternative would result in the following percent reductions in power output for the 100-MW and 250-MW replacements in comparison to the Proposed Action: 2 and 5 percent for the 3-Unit Operation and 3 and 8 percent for the 2-Unit Operation. The reduction in power output would result in less coal burned and lower deposition of metals and other COPECs in the portions of the study area analyzed for NGS and associated facilities (i.e., NGS Near-field, Northeast Gap Region of the Colorado River, Southwest Gap Region of the Colorado River, and the San Juan River) when compared to the Proposed Action. As a result of lower deposition of metals, the risk indicator or HQ for special status aquatic species would be slightly reduced in each of the study areas compared to the Proposed Action. Although there is a slight reduction in Project risks from mercury and selenium, the combination of Tribal PFR Alternative with baseline fish tissue concentration would represent the same risks and effects as discussed for the Proposed Action and the Natural Gas PFR Alternative.

There is a potential for surface water withdrawal from rivers and streams, or reservoirs for the purpose of providing water source for the project. There is a potential for effects on special status aquatic species if they occur in water sources used for withdrawals. The location of water sources and the water volumes have not been identified at this time. The potential occurrence of special status species would have to be considered, and withdrawal timing restrictions could be required. During preliminary feasibility studies, operations to use groundwater, or municipal water should be considered to avoid direct effects on aquatic communities.

3.13.4.6.2 Proposed Kayenta Mine Complex

The effects of the Tribal PFR Alternative from emissions and groundwater pumping on northern leopard would be the same as described for the Proposed Action and the Natural Gas PFR Alternative. There would be negligible effects on northern leopard frog proposed KMC emissions and groundwater pumping in relation to the 8.1 million tpy (3-Unit Operation) and 5.5 million tpy (2-Unit Operation) coal production operations.

3.13.4.6.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

There would be no changes in the operations of the WTS, STS, or communications sites if the Tribal Gas PFR Alternative were implemented. Impacts would be negligible to special status fish species that occur in streams crossed by the WTS and STS, as described for the Proposed Action. Best management practices and applicant-committed protection measures would be implemented to reduce impacts to a negligible level for special status fish species.

3.13.4.6.4 Project Impact Summary – All Project Components

In summary, the Tribal PFR Alternative would result in 2 to 8 percent power reduction at NGS compared to the Proposed Action, which would result in lower emissions and deposition of metals within the study area. As a result of lower deposition of metals, the risk indicator or HQ for special status aquatic species would be slightly reduced in each of the study areas compared to the Proposed Action. NGS emissions under this alternative by themselves represent a negligible risk on all species, as indicated by the very small HQ values. The effects of the Tribal PFR Alternative in combination with baseline fish tissue concentrations would be the same as described for the Proposed Action and the Natural Gas PFR Alternative. The reason for same effects is that the baseline fish concentrations dictate the risks for special status aquatic species in all portions of the study area.

3.13.4.6.5 Cumulative Impacts

The combination of NGS and proposed KMC emissions under the Tribal PFR Alternative plus other cumulative deposition sources would result in the same total cumulative emission effects as described for the Proposed Action. The only difference is that the NGS contribution to total cumulative emissions would be slightly less compared to the Proposed Action, as indicated by slightly lower HQs. However, the project risk and contribution is so small that it does not change the overall effects to special status species.

3.13.4.7 No Action

3.13.4.7.1 Navajo Generating Station

Emissions under the No Action Alternative would represent existing conditions plus other cumulative sources with the exclusion of current NGS emissions. The elimination of current NGS emissions would subtract a very small emission level from existing conditions. The effect of No Action emissions and deposition on aquatic species would be the same as described in the NGS Near-field, Gap Regions, and San Juan River ERAs for baseline conditions (Ramboll Environ 2016a,b,c). The following information describes the effects of the No Action Alternative on special status aquatic species.

- NGS Near-field – There would be negligible risks to federally listed razorback sucker or other special status species such as flannelmouth sucker from mercury and selenium because HQs for surrogate fish species were below 1. There would be no injury or loss of individual fish from arsenic, mercury, and selenium exposure due to the negligible risk indicated for mercury and selenium. There is no critical habitat located within the NGS Near-field study area.
- Northeast Gap Region – There would be negligible risks to federally listed bonytail, Colorado pikeminnow, humpback chub, and razorback sucker and other special status aquatic species such as bluehead sucker, flannelmouth sucker, and speckled dace from arsenic, mercury or selenium, as indicated by HQs being less than 1. There would be no injury or loss of individual fish from arsenic, mercury, and selenium exposure. There would be no effect on critical habitat for the federally listed fish species, because water quality standards for mercury and selenium are not exceeded.

- Southwest Gap Region – There would be potential risks to federally listed razorback sucker and special status species such as flannelmouth sucker and speckled dace from mercury and selenium, as indicated by HQs exceeding 1 due to baseline fish tissue concentrations. There would be negligible risk to humpback chub from arsenic, mercury or selenium, because the HQ is less than 1. There is the potential for minor loss of individual humpback chub, based on toxicity effects. No effect is expected for razorback sucker because it currently does not occur in the Southwest Gap Region. There would be a minor effect on the water element of critical habitat for humpback chub and razorback sucker in the Southwest Gap Region, based on exceedance of selenium water quality standards.
- San Juan River – There would be potential risk to federally listed Colorado pikeminnow and other special status species such as speckled dace from mercury and selenium, because HQs were greater than 1. There would be a negligible risk to razorback sucker as indicated by HQs being less than 1. There is the potential for minor loss of individual Colorado pikeminnow and razorback sucker, based on toxicity effects. There would be a minor effect on the water element of critical habitat for Colorado pikeminnow and razorback sucker in the Southwest Gap Region, based on exceedance of selenium water quality standards.

3.13.4.7.2 Proposed Kayenta Mine Complex

One special status species, northern leopard frog, occurs within the study area for the proposed KMC N-Aquifer. The effect of emissions from the No Action Alternative would be the same as baseline conditions analyzed in the proposed KMC ERA (Ramboll Environ 2016d). Emissions under the No Action Alternative would subtract the very small contribution from the proposed KMC facilities. Because the elimination of emission effects from the proposed KMC facilities would be very small, the resulting metal concentrations in waterbodies would be nearly the same as baseline conditions characterized in the proposed KMC ERA. There would be no effect of emissions from the proposed KMC facilities on northern leopard frog. Groundwater pumping under the No Action Alternative would reduce flow into Begashibito Wash by approximately 18 percent from 2020 rates, which represents potential habitat for the northern leopard frog.

3.13.4.7.3 Transmission Systems and Communication Sites

The NGS transmission system is an established part of the western U.S. transmission grid and supports reliability and delivery of power throughout the region, well beyond the power generated by the NGS. Therefore, under the No Action Alternative it is likely that that one, several, or all of the land owners/managers of the transmission line rights-of-way and communication site leases would renew some portion of the facilities to keep the power grid performing as expected.

In the event it is determined that some or all of the transmission systems and communication site ROWs are not renewed, a lengthy study and permitting process would need to occur before any decommissioning is initiated due to the essential and integral nature of these facilities with the western electric grid. As noted in Section 2.3.3, up to 4,826 acres within and alongside the transmission system corridors could be temporarily disturbed if the entirety of the transmission systems and communication sites were decommissioned and removed.

3.13.4.7.4 No Action Impact Summary – All Project Components

The No Action Alternative would result in slightly lower level effects to special status aquatic species compared to the Proposed Action. The impact level would be reduced by eliminating NGS emissions, proposed KMC mining disturbance and groundwater pumping, and operation and maintenance activities for the transmission systems. However, the elimination of current NGS emissions would subtract a very small emission level from existing baseline conditions. Potential risks to special status species would occur in the Southwest Gap Region and San Juan River due to baseline fish tissue concentrations. There would be a minor effect on the water element of critical habitat for humpback chub and razorback sucker in the Southwest Gap Region and Colorado pikeminnow and razorback sucker in the San Juan

River, based on exceedance of mercury or selenium water quality standards. There would be no effect of emissions from the proposed KMC facilities on northern leopard frog. Groundwater pumping under the No Action Alternative would reduce flow into Begashibito Wash, which represents potential habitat for the northern leopard frog, by approximately 18 percent from 2020 rates. Continued operation of all or part of the WTS and STS under the No Action Alternative would result in negligible effects to special status fish species.

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Section 3.14

Land Use

Acronyms and Abbreviations

1969 Lease	Navajo Project Indenture of Lease
BART	Best Available Retrofit Technology
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BM&LP Railroad	Black Mesa & Lake Powell Railroad
BO	Biological Opinion
CAP	Central Arizona Project
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CO_2	carbon dioxide
Co-tenants	Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
Development Fund	Lower Colorado River Basin Development Fund
EIS	Environmental Impact Statement
ERA	Ecological Risk Assessment
ESA	Endangered Species Act of 1973
HHRA	Human Health Risk Assessment
km	kilometer
KMC	Kayenta Mine Complex
kV	kilovolt
kW	kilowatt
MW	megawatt
N-Aquifer	Navajo Aquifer
NEPA	National Environmental Policy Act of 1969, as amended
NGS	Navajo Generating Station
NGS Participants	U.S. (Reclamation), Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
NHPA	National Historic Preservation Act
NNEPA	Navajo Nation Environmental Protection Agency
NO_2	nitrogen dioxide
NO_X	nitrogen oxide
OSMRE	Office of Surface Mining Reclamation and Enforcement
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 microns or less
PFR	Partial Federal Replacement
PWCC	Peabody Western Coal Company
Reclamation	U.S. Bureau of Reclamation
ROW	Right-of-way
SO_2	sulfur dioxide

SRP	Salt River Project Agricultural Improvement and Power District
STS	Southern Transmission System
U.S.	United States
USEPA	U.S. Environmental Protection Agency
WTS	Western Transmission System

Contents

3.14 Land Use 3.14-1
3.14.1 Regulatory Framework 3.14-1
3.14.1.1 Navajo Generating Station 3.14-1
3.14.1.2 Proposed Kayenta Mine Complex 3.14-1
3.14.1.3 Transmission Systems and Communication Sites 3.14-2
3.14.2 Study Areas 3.14-3
3.14.3 Affected Environment 3.14-3
3.14.3.1 Navajo Generating Station 3.14-4
3.14.3.2 Proposed Kayenta Mine Complex 3.14-5
3.14.3.3 Transmission Systems and Communication Sites 3.14-10
3.14.4 Environmental Consequences 3.14-18
3.14.4.1 Issues 3.14-18
3.14.4.2 Assumptions and Impact Methodology 3.14-18
3.14.4.3 Proposed Action 3.14-19
3.14.4.4 Natural Gas Partial Federal Replacement Alternative 3.14-22
3.14.4.5 Renewable Partial Federal Replacement Alternative 3.14-23
3.14.4.6 Tribal Partial Federal Replacement Alternative 3.14-24
3.14.4.7 No Action Alternative 3.14-25
3.14.5 References 3.14-26

List of Tables

Table 3.14-1 Anticipated Mine Reclamation through 2019 for Permanent Program Affected Lands 3.14-9
Table 3.14-2 Plant Species Selected for Cultural Planting 3.14-9
Table 3.14-3 Land Ownership Crossed by the WTS and STS 3.14-10
Table 3.14-4 Location and Size of Communication Sites 3.14-11
Table 3.14-5 Special Designation Areas Crossed by WTS 3.14-12

List of Figures

Figure 3.14-1 Proposed KMC Reclamation Status 3.14-6
Figure 3.14-2 Special Management Areas along the WTS 3.14-13
Figure 3.14-3 Special Management Areas along the STS 3.14-16

3.14 Land Use

This section describes the current state of Federal and Tribal Trust Land for tribal residential and commercial land ownership and land uses, including livestock grazing, and recreational resources in and around the Navajo Generating Station (NGS) and associated facilities, the proposed Kayenta Mine Complex (KMC), and the transmission systems and communication sites. The potential impacts to these resources due to the Proposed Action, action alternatives, and No Action Alternative also are described.

3.14.1 Regulatory Framework

3.14.1.1 Navajo Generating Station

The NGS and associated facilities 1) include the plant site, ash disposal site, coal transportation and handling facilities, and the Lake Powell pumping station (Section 1.7). Rights-of-way (ROWs) include those for the Black Mesa & Lake Powell (BM&LP) Railroad, the pipeline and the road between Lake Powell and the plant, and the 230-kilovolt (kV) tie line.

Applicable regulations for the NGS include those for ash disposal; which is regulated by the United States Environmental Protection Agency (USEPA) under subtitle D of the Resource Conservation and Recovery Act as published in the Federal Register on April 17, 2015. The asbestos landfill is regulated by the USEPA under 40 Code of Federal Regulations (CFR) Part 61.150. The portion of the water intake pipe located on National Park Service (NPS) land is regulated by 36 CFR Part 14 (Rights-of-Way) and 16 USC Section 1248 (Easements and Rights-of-Way). The water pumped from Lake Powell is regulated by the United States (U.S.) Bureau of Reclamation (Reclamation) Contract No. 14-06-300-5033.The maximum volume of water allowed by the terms of the contract is 40,000 acre-feet per year. In the event of a chemical spill or accidental release remedial actions would be regulated by the Comprehensive Environmental Response, Compensation, and Liability Act and the Superfund Amendments and Reauthorization Act.

The BM&LP Railroad is a privately owned, closed-loop system without connection any other railroad; therefore, it is not subject to Federal Railroad Commission jurisdiction. It must however, comply with the terms and conditions of 25 CFR Part 169, which governs ROWs over Indian lands, as the railroad is entirely located on tribal trust lands.

3.14.1.2 Proposed Kayenta Mine Complex

The Surface Mining Control and Reclamation Act of 1977 (SMCRA) (30 USC Section 1265) is the primary federal law that regulates the environmental effects of coal mining in the U.S. One of several regulations is relevant, depending on the date that mining began. Generally, reclamation and release of reclaimed land from regulatory authority are controlled under Pre-Law regulations or are administered under Initial Program regulations (30 CFR Part 710 to 725), or Permanent Program regulations (30 CFR Part 810 to 828). (**Appendix 1D**).

SMCRA regulations do not require that Pre-Law lands receive reclamation or regulatory release from bonding or permit coverage; however, the leases for Kayenta and the former Black Mesa mines do require grading and seeding of Pre-Law lands. A total of 1,294 acres of Pre-Law lands on Kayenta Mine and a total of 1,266 acres of Pre-Law lands on the former Black Mesa Mine have been disturbed, graded and seeded.

Lands disturbed under the Initial Program are required to be restored so that these lands are capable of supporting the land uses existing prior to mining, or better uses as determined by Office of Surface Mining Reclamation and Enforcement (OSMRE) evaluation. Although there is no bond held by OSMRE for reclamation of Initial Program lands, the reclamation must be reviewed by OSMRE to obtain release from coverage under the Initial Program in a process called Termination of Jurisdiction. Release by

OSMRE under a Termination of Jurisdiction does not constitute a release from any liabilities associated with the leases through the Bureau of Indian Affairs (BIA).

SMCRA requires mining companies to post a reclamation performance bond sufficient to cover the cost of reclaiming the lands covered by the SMCRA Permanent Program permit. Successful reclamation is defined as the restoration of land and water resources and the environment impacted by coal mining practices including measures for the conservation and development of soil, water (excluding channelization), woodland, fish and wildlife, recreation resources, and agricultural productivity (SMCRA 2012). The bond is based on the cost of having a third-party contractor complete the required mitigation and reclamation work if the permittee, Peabody Western Coal Company (PWCC) in this situation, does not fulfill those requirements for any reason. The bond is made payable to OSMRE and covers completion of all requirements contained in SMCRA, the permanent program regulations, the permit document, and the reclamation plan.

Since the former Black Mesa Mine currently is administered through the Initial Program, any lands affected from December 16, 1977, through to the present time are subject to the Initial Program regulations. There is no OSMRE bond coverage for the former Black Mesa Mine areas as all affected lands are Pre-Law or covered under the Initial Program; however, the former Black Mesa Mine area is covered by a bond for $47,862,000 held by BIA related to the coal leases for this area. Of the 4,891 acres of Initial Program lands that have been affected at the former Black Mesa Mine, there are 1,608 acres of lands that have been reclaimed in accordance with Initial Program regulatory requirements and been released from coverage by OSMRE through a Termination of Jurisdiction determination.

The bond held by OSMRE for the Kayenta Mine is $245,192,000 in the form of a corporate surety. As part of the 2010 permit renewal process, OSMRE reviewed the reclamation costs and associated bonding and determined that the current (2010 to 2015) 5-year permit term bond exceeds the cost of reclamation by more than $20 million and is sufficient to ensure completion of the approved reclamation plan by OSMRE in the event of bond forfeiture. The actual reclamation costs are evaluated as part of the permit renewal every 5 years and as part of the mid-term review. If changes occur in the operations that would necessitate a bond review, such as request for bond release, the bond is evaluated prior to approval. In addition, beginning in 2011 the bond amount is subject to an annual inflation adjustment. Permit renewals would include an evaluation of reclamation costs and associated bonding with any adjustments made as needed. Demolition of Kayenta Mine structures is included as part of the OSMRE reclamation bond.

3.14.1.3 Transmission Systems and Communication Sites

The Western and Southern Transmission Systems (WTS and STS, respectively) were built and operate under the following federal and industry standards:

- Federal Energy Regulatory Commission Mandatory Reliability Standards;
- Arizona Corporation Commission regulations;
- Rural Utilities Service regulations (U.S. Department of Agriculture 7 CFR Part 1738);
- National Electrical Safety Code;
- Occupational Safety and Health Administration Regulations for Electric Power Generation, Transmission, and Distribution (29 CFR Part 1910.269);
- American National Standards Institute Z133.1 Standard for Tree Care Operations: Pruning, Trimming, Repairing, Maintaining, and Removing Trees and Cutting Brush – Safety Requirements;

- American National Standards Institute A300 Standards for Tree Care Operations: Tree Shrub, and other Woody Plant Maintenance;
- 25 CFR Part 169 where on tribal lands;
- Public Law 96-491 where the WTS passes through the Moapa Corridor;
- Any portions of USC Title 16 that pertain to operation and maintenance within ROWs in the Kaibab or Prescott National Forests (NF);
- Decisions contained within the Kaibab and Prescott NF Land Resource Management Plans;
- Decisions contained within the Bureau of Land Management (BLM) Arizona Strip, Hassayampa, Kanab, St. George, Caliente, and Las Vegas field offices Resource Management Plans (RMPs);
- Decisions contained within the Aqua Fria RMP; and
- Standards and Guidelines contained within the Kaibab and Prescott Land Resource Management Plans.

The communications that are located within the Navajo Nation are subject to the rules and regulations of the Navajo Nation Telecommunications Regulatory Commission including:

- Navajo Telecommunications Regulatory Act as codified in Chapter 5 Title 21 of the Navajo Nation Code; and
- Navajo Telecommunications Regulatory Commission Chapter 5 Title 2 of the Navajo Nation Code. The STS and Moenkopi Switchyard are operated by the Arizona Public Service Company and the WTS is operated by NV Energy.

3.14.2 Study Areas

The study area for land use for the Proposed Action, action alternatives, and cumulative analysis includes the NGS site and associated facilities (as defined in Section 3.14.1), the proposed KMC, and the WTS and STS ROWs including a 1-mile buffer on each side. The study area for the Proposed Action, action alternatives, and cumulative analysis for recreation is the viewshed surrounding project facilities.

3.14.3 Affected Environment

The NGS and associated facilities are located in northern Arizona in Coconino and Navajo counties, largely within the Navajo Nation; a small segment of the water intake pipeline is located on NPS land. The proposed KMC is located on Navajo Nation and Hopi Tribe lands, in Navajo County. The WTS and associated communication sites are located within Coconino and Mohave counties, Arizona; Kane and Washington counties, Utah; and Lincoln and Clark counties, Nevada. The STS and associated communication sites are located within Coconino, Yavapai, and Maricopa counties in Arizona. The primary land use in this area is livestock grazing by the Navajo people (PWCC 2012 et seq.). The majority of the area is sparsely populated with dispersed residential dwellings or small communities. Commercial uses include small retail outlets and gas stations located along major transportation routes and in or adjacent to local communities.

The transmission systems and associated facilities (substations, switchyards and communication sites) are part of the western electric grid. The WTS and STS cross through a variety of lands ranging from tribal (Navajo Nation) to federally managed lands (BLM, Forest Service, and U.S. Bureau of Reclamation [Reclamation]) lands. The primary use of tribal lands would be the same as for the NGS and proposed KMC sites. The federally managed lands are managed for multiple uses including mineral extraction, preservation of wildlife and habitat, and recreation.

The 19 project communication sites are located within the plant or substation boundaries or off-site in remote locations.

3.14.3.1 Navajo Generating Station

3.14.3.1.1 Land Use

The NGS and associated facilities were constructed in the 1970s. The NGS is located in Coconino County approximately 3 miles east of Page, Arizona, within the LeChee Chapter of the Navajo Nation. The 1997 LeChee Community-Based Land Use Plan (LeChee 2004) emphasizes the desire to develop emergency response facilities, schools, senior and youth facilities, and housing developments and infrastructure. The developable area of LeChee extends about 10 miles south of Page. Agriculture including livestock grazing, farming, enhancing rangelands, and designing water capture systems are signs of a successful community and are important land uses for all communities including the LeChee.

The NGS and associated facilities occupy approximately 3,485 acres and contain the power plant, various landfills including an ash disposal site and an asbestos landfill. There also is a water pump station; two associated pipelines; a 230-kV transmission line; and the BM&LP Railroad and turnaround loop (see **Figure 1-3**). Access to the NGS site is via federal, state, county, private and Navajo Nation roads outside of leased lands.

The asbestos landfill is a USEPA-regulated landfill that occupies 3 acres within the NGS site partitioned into 24-foot by 30-foot cells approximately 4 feet deep. Less than half of the designated site is disturbed. From 2008 to 2014, NGS disposed of 124 cubic feet of asbestos containing material (**Appendix 1B**). Asbestos containing material deposited at the land fill is covered by six inches of compacted non-asbestos-containing material every 24 hours. Once a cell has been covered with soil it cannot be disturbed without USEPA notification. The NGS environmental department conducts monthly inspections of the asbestos landfill and applies corrective actions as necessary.

The ash disposal site is located approximately 1.5 miles to the east of the NGS site and is regulated as a Coal Combustion Residuals (CCR) landfill. CCRs include bottom ash, fly ash, boiler slag, and flue gas desulfurization materials. NGS is required to regularly post documents of compliance to an operating record, publicly accessible internet site, and submit notification to the Navajo Nation. It is required for a qualified inspector to inspect the landfill every seven day for structural weaknesses. The boundary of the ash disposal site is approximately 765 acres with a disposal capacity of 38 million cubic yards (**Appendix 1B**). Approximately 50 to 90 percent (depending on market demand) of the fly ash generated at the NGS is sold to Headwaters Inc. to be used in manufacturing concrete. In 2014 an estimated 18 million cubic yards of ash had been disposed of in the ash landfill, leaving an additional capacity of 19 million cubic yards.

The water intake system includes the pump station, two 30-inch pipelines and power lines to supply power for the pumps. The pump station occupies approximately 4.5 acres and the pipelines and power lines are located within a 2.9-mile-long ROW, all on Navajo Tribal Trust and NPS land.

The BM&LP Railroad is a private and closed loop system operated and maintained by the NGS with the sole purpose of transporting coal from the proposed KMC silo complex to the NGS. The railroad is powered by a 50-kV overhead electric line and is approximately 80 miles in length, including the loops at each end (see **Figure 1-8**). The entire length of the railroad is located on the Navajo Nation. When the NGS is operating at full capacity, the train makes 3 trips per day and operates 24 hours per day, 7 days a week.

3.14.3.1.2 Recreation

The residents of the LeChee Community enjoy dispersed recreation in the canyon areas where they hike and hunt. Other recreation in the vicinity of the NGS involves the large number of visitors to Lake Powell, Glen Canyon National Recreation Area, Horseshoe Bend Overlook, the Antelope Canyon Tribal Park, and the Grand Canyon. The tourism industry is a large contributor to the economy of Page, Arizona.

Antelope Canyon Tribal Park is immediately to the south of the NGS. Navajo guided tours of the canyon are popular with tourists. It is known as the most visited and most photographed slot canyon in the Southwest.

Vermilion Cliffs National Monument and Paria Canyon—Vermilion Cliffs Wilderness Area are west of the NGS. The monument is approximately 280,000 acres and is bounded on the north, east, and south by the 112,500-acre Paria Canyon–Vermilion Cliffs Wilderness Area. The monument and wilderness area offer visitors the opportunity to experience towering cliff walls streaked with desert varnish, huge red rock amphitheaters, sandstone arches, wooded terraces, and hanging gardens. This wilderness area also contains archaeological sites.

The majority of the railroad ROW passes through areas that provide opportunities for dispersed recreation. However, the recreational opportunities between the State Highway 98 crossing and the NGS include Lake Powell and the Antelope Point Marina.

3.14.3.2 Proposed Kayenta Mine Complex

3.14.3.2.1 Land Use

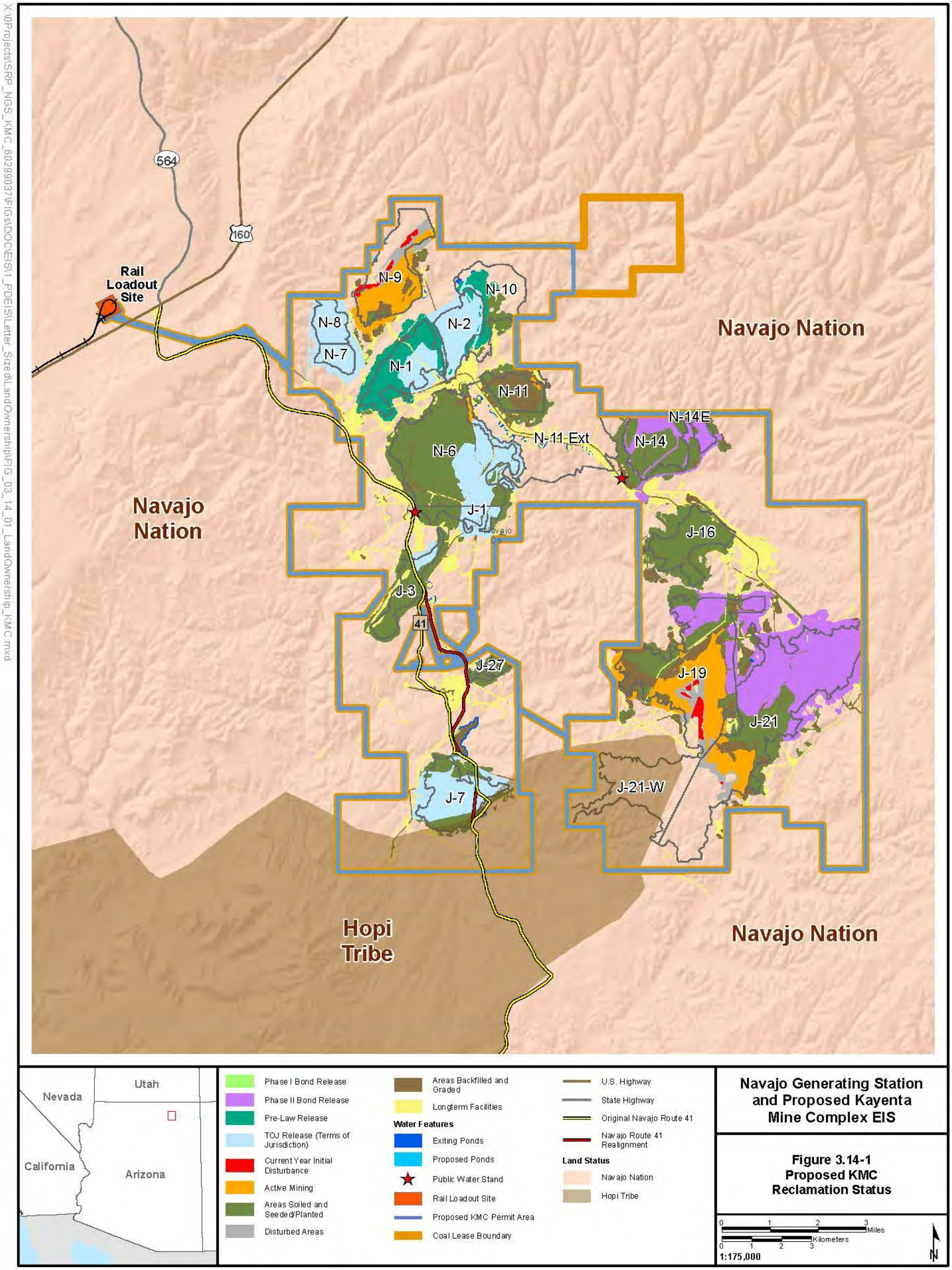
The proposed KMC is located approximately 15 miles south of Kayenta, Arizona, in Navajo County on the Hopi Reservation and the Navajo Nation Chapters of Chilchinbeto, Forest Lake, Kayenta, and Shonto (**Figure 3.14-1**). The proposed KMC would consist of the former Black Mesa Mine (18,857 acres) and the Kayenta Mine (44,073 acres). Native undisturbed areas exist within the proposed KMC where mining has not taken place. These areas consist primarily of Pinyon-juniper woodland, Big Sagebrush shrubland, and reclaimed lands (see **Table 3.8-5**).

3.14.3.2.1.1 Habitation

Approximately 150 Navajo residents live in dispersed houses within or adjacent to the proposed KMC permit boundary (PWCC 2012 et seq.). Frequently, multiple families or multiple generations reside in a single dwelling. As the mine areas are developed, residents occasionally need to be relocated to different areas. PWCC incurs the expense to move or construct housing at a location agreed to by the residents. All relocations planned for the 2015-2020 time period were completed by the end of 2015 (PWCC 2015a).

3.14.3.2.1.2 Livestock Grazing

Many residents graze livestock (mainly cattle, sheep, and goats) on reclaimed and undisturbed lands within the proposed KMC permit boundary for a food source and for economic and cultural reasons. Livestock grazing is the primary pre-mine use of the land and occurs year-round. Wildlife habitat and harvest of cultural plants also are recognized post-mining land uses. Grazing permits issued by the BIA prescribe the units and number of animals that can be grazed. Historically the project area has been grazed year-round; a practice that has proven to be not sustainable for the region. PWCC first allowed livestock grazing on initial program reclaimed lands in 1998 under a grazing plan that required deferred or rest rotation grazing utilizing multiple pastures. Planting with cool season grasses has proved to be successful at extending the grazing period throughout all seasons provided adequate precipitation is received. Multiple water sources and mineral blocks have been used to draw livestock to various areas, reducing grazing pressure throughout the pastures. PWCC has been successful at educating local residents on rangeland carrying capacities and appropriate stock rates and has assisted the ranchers by developing a holding pasture and providing transportation to deliver the cattle to market (PWCC 2005).



Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 3.14-1
Proposed KMC Reclamation Status

8/29/2016

At the request of residents in the vicinity of the N-14 coal resource area, PWCC reclaimed approximately 84 acres to be less sloped and have greater infiltration to benefit forage vegetation. The improved pastures were seeded with cicer milkvetch, pubescent wheatgrass, Russian wildrye, and thickspike wheatgrass which have responded well in reclaimed areas in this region.

PWCC is proposing to leave 51 sediment control ponds available as water sources for livestock and wildlife in the proposed KMC; 19 currently exist and are available for livestock and wildlife, 1 exists and is proposed for post-mining retention, and 31 are a combination of existing and future sediment control ponds. All of these 31 ponds meet, or would be upgraded to meet, permanent pond design criteria (PWCC 2012 et seq.). It is recognized that livestock and wild horse trespass occurs throughout the mine area and can result in areas (particularly near water sources) that receive excessive pressure. Proper management of grazing on reclaimed lands has presented challenges and PWCC acknowledges that grazing typically has been conducted on the honor system where PWCC has the responsibility of monitoring pastures for over-utilization and notifying residents when they need to move their livestock (PWCC 2012 et seq.). Drought conditions and over-grazing have compromised the overall condition of certain reclaimed areas where grazing historically was allowed and in 2015 a temporary moratorium was placed on livestock grazing on reclaimed areas.

3.14.3.2.1.3 Agriculture

Other uses of the land by residents living within the permit boundary include the gathering of plants for food, medicine, and cultural purposes; gathering firewood for home heating fuel, and farming small agricultural plots (approximately 4 to 5 acres in size). The plots typically are used for growing corn (PWCC 2012 et seq.). Irrigation is not practiced in these plots on the proposed KMC permit area. Due to variable precipitation events it is not uncommon for plots to have low or no production. There are no designated Prime Farmland soils or alluvial valley floors within the purposed KMC permit area.

3.14.3.2.1.4 Mine Reclamation

Reclamation of mine areas primarily is intended to achieve vegetation communities that support livestock grazing and wildlife habitat. Section 3.6.2, Soils, and **Appendix 1D** detail the parameters for suitable overburden. Per the draft Land Use Plan for the former Black Mesa Mine developed by the BIA and Navajo Nation, all pre-mine customary use areas would be recognized after reclamation and returned to the Navajo Nation. The purpose of reclamation is to restore the affected lands to the approximate landforms that existed prior to mining and to establish a diverse, effective, and permanent vegetative cover similar in seasonal variety, diversity, and plant composition to the native vegetation on undisturbed lands surrounding the mining operation. Mine reclamation is accomplished by grading; sampling and evaluating spoil/overburden for suitability as a subsoil; placement of suitable subsoil if needed; replacement of topsoil, and seeding and planting. After seeding and planting, the site is monitored for vegetative success and the presence of erosional issues such as rills and gullies. PWCC conducts monitoring twice a year on select reclaimed sites to ensure adequate reclamation and identification of noxious or invasive weed species. Successful reclamation can increase forage vegetation by ten times compared to the pre-disturbance condition (PWCC 2012 et seq.). Maintenance, including reseeding and repair of erosional issues with subsequent re-seeding, is performed on the revegetated areas as needed. Additional maintenance of reclaimed areas includes fencing and fence maintenance, drainage maintenance, and grazing. PWCC has established the following reclamation goals (PWCC 2015b):

- Manage reclaimed areas to meet reclamation standards;
- Use grazing to remove standing dead litter and promote new growth;
- Aid in establishing new seedings; and
- Demonstrate the utility of reclaimed lands for various seasons of use.

The seeding used at Kayenta Mine and former Black Mesa Mine was designed to support post mining land uses of rangeland grazing, wildlife habitat, and the establishment of populations of culturally significant plants and has restored an element of habitat diversity. The standard rangeland mix for revegetation consists of 12 cool and warm season grasses, 2 legumes, 4 forbs, and 5 shrubs or subshrubs (PWCC 2005). The majority of these plants are native to the area. Overall, the reclaimed areas produce greater amounts of forage vegetation than the surrounding undisturbed pinyon/juniper and sagebrush communities. For this reason livestock stocking rates have tended to be significantly higher on the reclaimed areas than on the native rangelands. Reclamation of non-vegetated habitat areas such as rock slopes also is conducted (for additional information on mine reclamation see **Appendix 1D**).

Per SMCRA, all disturbed areas shall be restored to the conditions that were supported before mining or to higher or better uses. As described previously, the post-mining land use for the proposed KMC is livestock grazing and wildlife habitat as it was prior to disturbance from mining-related activities. According SMCRA, an alternative post mining land use can be approved by OSMRE after the permittee has received written approval from the landowners. Alternative post mining land uses, including uses for heavy or light industry (solar or wind power facilities), for the areas disturbed by mining at the KMC are at the discretion of the Navajo and Hopi Tribes for their respective lands and can be revised under an active Permit Application Package at the Tribes request.

Of the 6,157 acres of Pre-Law and Initial Program affected land at the former Black Mesa Mine, 5,263 acres have been backfilled and graded; of those, 3,857 acres have been topsoiled and seeded, and 1,266 acres have been seeded without being topsoiled (Pre-Law reclamation). PWCC has received Termination of Jurisdiction for 1,608 acres from OSMRE.

Of the 19,330 acres of affected Pre-Law, Initial, and Permanent Program land at Kayenta Mine, 14,546 acres have been backfilled and graded; of those, 11,328 acres have been topsoiled and seeded, and 1,294 have been seeded without being topsoiled (Pre-Law reclamation). On the Kayenta Mine, there are 2,450 acres that have been released through Termination of Jurisdiction, 3,710 acres that have been released from Phase I bonding, and 3,694 acres that have been released from Phase II bonding (**Figure 3.14-1**). There are no lands for which Phase III bond release has occurred.

Under 30 USC Section 1265(b)(16) and 30 CFR Part 816.100, reclamation is required to be initiated as close as practible to the same time period as the surface coal mining operations. Typically, the amount of time required for backfilling, topsoiling and seeding is approximately equal to the time between initiating mining activities and initiating grading (PWCC 2012 et seq.). Factors that affect the mine reclamation schedule include annual mining operations, coal production requirements, and the availability of areas ready to be graded (PWCC 2012 et seq.).

Planned post-mining land use specifies that facilities would be reclaimed unless they have been approved as a component of the post-mining land use plan. Facilities not be left as part of the post-mine land use would be decommissioned when no longer needed to support mining activities. Activities on the reclaimed mine areas through the end of 2019 include continued monitoring of mine reclamation, reseeding as needed, and repair of any erosional features that have developed on reclaimed areas. PWCC's existing reclamation program, including ongoing monitoring and repair for the reclaimed areas at the former Black Mesa Mine, is included in **Appendix 1D**. Environmental monitoring and reclamation activities are reported annually by PWCC to the OSMRE in a joint report prepared for the Kayenta Mine and former Black Mesa Mine. Compliance with OSMRE regulations and the Reclamation Plan can be found by reviewing the reclamation status in the annual reports. Reclamation on mine areas would continue at the Kayenta Mine through 2019. **Table 3.14-1** provides an estimate of acreage in each stage of reclamation from 2015 through 2019 for each active mine area. **Appendix 1D** contains additional details on existing disturbance and reclamation. Active reclamation is occurring in mine areas J-19, J-21, N-6, N-9, and N-11 (see **Figure 3.14-1** and **Table 3.14-1** for reclamation status). Between 2015 and

2019 the reclamation schedule estimates 1,521 acres would be backfilled and graded and 1,752 acres would be topsoiled and seeded.

Table 3.14-1 Anticipated Mine Reclamation through 2019 for Permanent Program Affected Lands

	Total Land Disturbed (acres)[1]	Total Current Land Graded (acres)[1]	Total Current Land Topsoiled and Seeded (acres)[1]
Mine Area N-9	1,331	270	60
Mine Area N-11	877	786	393
Mine Area J-19	3,927	2,493	1,727
Mine Area J-21	4,262	3,676	3,353

[1] Data as of December 15, 2015.

3.14.3.2.1.5 Cultural Planting Areas

Many of the north-facing slopes have been reclaimed as cultural planting areas. North facing slopes are selected because they represent an environment with a moderate or well-balanced supply of moisture. The plant species for cultural planting areas were selected through consultation with the Hopi Cultural Preservation Office, Black Mesa residents, Navajo medicine men, and herbalists. Culturally significant plants are established through a combination of seeding, planting from nursery stock, and transplanting from nearby areas. In the Black Mesa portion of the proposed KMC, approximately 90 acres have been reclaimed with cultural plantings in the J-7 and N-6 coal resource areas and approximately 383 acres at Kayenta Mine J-16, J-19, J- 21, N-6, N-7, N-11, and N-14 coal resource areas. Plant types selected for inclusion in cultural plantings are listed in **Table 3.14-2**. New plant species are added to the list as necessary through ongoing consultation.

Table 3.14-2 Plant Species Selected for Cultural Planting

Vegetation Type	Species
Forbs	Baker cryptantha, barestem larkspur, beardlip penstemon, blue loco, bottlebrush squirreltail, brickelia spp., Colorado, four o' clock, common spectaclepod, common sunflower, desert globemallow, desert Indian paintbrush, Fendler's spurge, field morning glory, firecracker penstemon, filaree, Fort Wingate milkvetch, golden crownbeard, golden fleece, golden sego lilly, goosefoot, hoary townsendia, Hopi tea greenthread, littleleaf globemallow, mid bladderpod, narrowleaf paintbrush, Navajo tea, palmer penstemon, Parry bellflower, prairie spiderwort, prostrate pigweed, redroot wildbuckwheat, rocky mountain beeplant, scrambled eggs, scarlet globemallow, sego lilly, spike verbena, spring parsley, stemless four-nerve daisy, stemless townsendia, sulfur-flower buckwheat, Texas doveweed, thistle, toadflax beardtongue, torrey milkvetch, white prairie clover, whorled milkweed, wild onion, winged buckwheat, wooton sandpuff, yarrow
Grasses	Alkali sacaton, blue grama, false buffalograss, galleta, indian ricegrass, letterman's needlegrass, little bluestem, needle and thread grass, sand dropseed, side oats grama, spike muhly, western wheatgrass
Shrubs	Antelope bitterbrush, Apache plume, banana yucca, big sagebrush, blackbrush, broom snakeweed, cliff fendlerbush, four-wing saltbrush, fringed sagebrush, greasewood, green mormon tea, green rabbitbrush, Mexican cliffrose, mountain mahogany, narrowleaf yucca, New Mexico privet, pale desert-thorn, roundleaf buffaloberry, rubber rabbitbrush, shadscale, skunkbush sumac, small soapweed, Spanish bayonet, sticky-leaved rabbitbrush, threadleaf groundsel, Torrey Mormon tea, wild buckwheat, winterfat, wolfberry
Succulents	Hedgehog cactus, pincushion cactus, plains pricklypear, pricklypear, whipple cholla
Trees	Boxelder, freemont cottonwood, Gamble oak, one-seed juniper, pinyon pine, two needle pinyon, Utah juniper

Source: PWCC 2012 et seq.

Emphasis has been placed on plant materials collected from nearby reference sites due to their adaptability to climatic conditions. PWCC conducted research on germination treatments, propagation techniques, and nursery practices for those species with little historical information. Some species are injected with commercially available mycorrhizal strains prior to transplanting to stimulate root functions (PWCC 2012 et seq.). Cultural plant sites are continuously monitored to assess the success of site establishment, development, and successional change.

3.14.3.2.2 Recreation

Recreation activities in the vicinity of the proposed KMC consist primarily of dispersed recreation on Black Mesa, which is a prominent geographic feature of the Colorado Plateau. Typical activities include hiking, small game hunting, bird watching, and photography. Big game hunting is not permitted in the Black Mesa near the leasehold area; however, small game hunting may occur to a limited extent north of the leasehold area near the rim of Black Mesa (PWCC 2012 et seq.). No developed recreation is present in this area. Non-Navajo people are restricted to designated trails or routes unless they are accompanied by a tour guide or have a valid permit issued by the Navajo Parks and Recreation Department. Rock climbing, off-trail hiking, and off-road travel also are prohibited and considered trespassing (Discover Navajo 2015).

3.14.3.3 Transmission Systems and Communication Sites

The power generated by the NGS is delivered through the WTS and the STS. The transmission systems and associated facilities (transmission lines, substations, and communication sites) are part of the western electric grid. **Table 3.14-3** identifies land ownership for the two transmission systems and the number of miles that fall within each jurisdiction

Table 3.14-3 Land Ownership Crossed by the WTS and STS

Ownership	WTS (miles)	STS (miles)	Total Miles
BIA/Tribal (Navajo, Hopi, Kaibab, Moapa	20	96	116
Navajo Nation	2	94	96
Hopi Tribe	0	0	0
Kaibab Reservation	4	0	4
Moapa Tribe	14	0	14
BLM	201	27	228
Reclamation	7	1	8
National Park Service	3	0	3
Private	20	20	40
State	24	47	71
U.S. Forest Service	0	65	65
Total	**275**	**256**	**531**

Source: GIS analysis.

The NGS and associated facilities and the WTS and STS are supported by 19 communication sites that occur within the plant or substation boundary or off-site in remote locations (**Figure 1-14**). The Navajo Nation has issued permits for the Zilnez Mesa, Preston Mesa, and the Jack's Peak communication sites. The Salt River Project (SRP) is applying to the BIA for Section 323 grants for the continued use of the sites. The areas are cleared of vegetation periodically and are fenced for security purposes. **Table 3.14-4** lists the communication sites and their approximate locations.

Table 3.14-4 Location and Size of Communication Sites

Site Name	Approximate Location	Acres	Service
Apex to Crystal	7 miles northeast of Ellis Air Force Base in Clark County, Nevada	<1	WTS
Beaver Dam	17 miles west-northwest of St. George, in Washington County, Utah	Site Leased – No Acreage	WTS
Bill Williams	3.5 miles south of the City of Williams in Coconino County, Arizona	Site Leased – No Acreage	STS
Buckskin Mountain	33 miles northwest of Page in Kane County, Utah	Site Leased – No Acreage	WTS
Glen Canyon	14 miles northwest of Page in Kane County, Utah	Site Leased – No Acreage	WTS
Glendale	24 miles southwest of Mesquite in Clark County, Nevada	Site Leased – No Acreage	WTS
Jack's Peak	18 miles southwest of NGS in rural Coconino County, Arizona	1.75	STS
Moenkopi Substation	Moenkopi Switchyard yard in Coconino County, Arizona	Acreage Exists within Switchyard Site	STS
Mount Elden	1 mile north of Flagstaff in Coconino County, Arizona	Site Leased – No Acreage	STS
Mount Francis	5 miles southwest of Prescott in Yavapai County, Arizona	Site Leased – No Acreage	STS
Navajo and NGS	NGS site in Coconino County, Arizona	Acreage Exists within NGS Site	BM&LP Railroad, WTS, STS, and the APS Switchyard
Pipe Springs	1 mile north of Flagstaff in Coconino County Reservation, Mohave County, Arizona	<1	WTS
Preston Mesa	36 miles south of NGS in rural Coconino County, Arizona	<1	BM&LP Railroad and STS
Red Mountain	2 miles north of Boulder City in Clark County, Nevada	Site Leased – No Acreage	WTS
West Phoenix	APS West Phoenix Generating Station in Maricopa County, Arizona	Site Leased – No Acreage	STS
Westwing	Westwing receiving station in Maricopa County, Arizona	Acreage Exists within the Westwing Substation Site	STS
White Tank	6 miles west of Waddell in Maricopa County, Arizona	Site Leased – No Acreage	STS
Zilnez Mesa	40 miles southeast of NGS in rural Navajo County, Arizona	2.4	BM&LP Railroad

3.14.3.3.1 Western Transmission System

3.14.3.3.1.1 Land Use

The WTS is a 275-mile-long ROW that passes through the following states and counties; Arizona – Coconino and Mohave, Utah – Kane and Washington, and Nevada – Lincoln and Clark (see **Figure 3.14-2** and **Figure 1-14**). It originates at the NGS and terminates at the McCullough Substation southwest of Boulder City in Nevada. The WTS consists of a single 500-kV transmission line and two substations. **Table 3.14-5** details the jurisdictions and mileage crossed by the ROW.

Table 3.14-5 Special Designation Areas Crossed by WTS

Special Designation Areas	Area Name	Location	WTS Crossed (miles)
ACECs	Beaver Dam Slope	Washington County, Utah Lincoln County, Nevada Mohave County, Arizona	19
	Kanab Creek	Coconino and Mohave County, Arizona	1
	Lower Virgin River	Washington County, Utah	<1
	Mormon Mesa	Lincoln and Clark County, Nevada	24
	Rainbow Gardens	Clark County, Nevada	9
	River Mountains	Clark County, Nevada	1
National Monuments	Grand Staircase-Escalante	Kane County, Utah	20
National Recreation Area	Glen Canyon	Coconino County, Arizona	3

The existence of the transmission line is consistent with the Coconino, Mohave, Kane, Washington, Lincoln, and Clark County General/Comprehensive plans and the large majority of the ROW is located within the West Wide Energy Corridor (West Wide Energy Corridor 2015). The WTS crosses through seven BLM special designation areas, as indicated in **Table 3.14-5**.

Areas of Critical Environmental Concern (ACECs) are designated by the BLM through land use plans to protect areas that have been identified as having unique cultural, historic, scenic, or biological values. National monuments are designated presidentially or congressionally to protect areas with historic or scientific values.

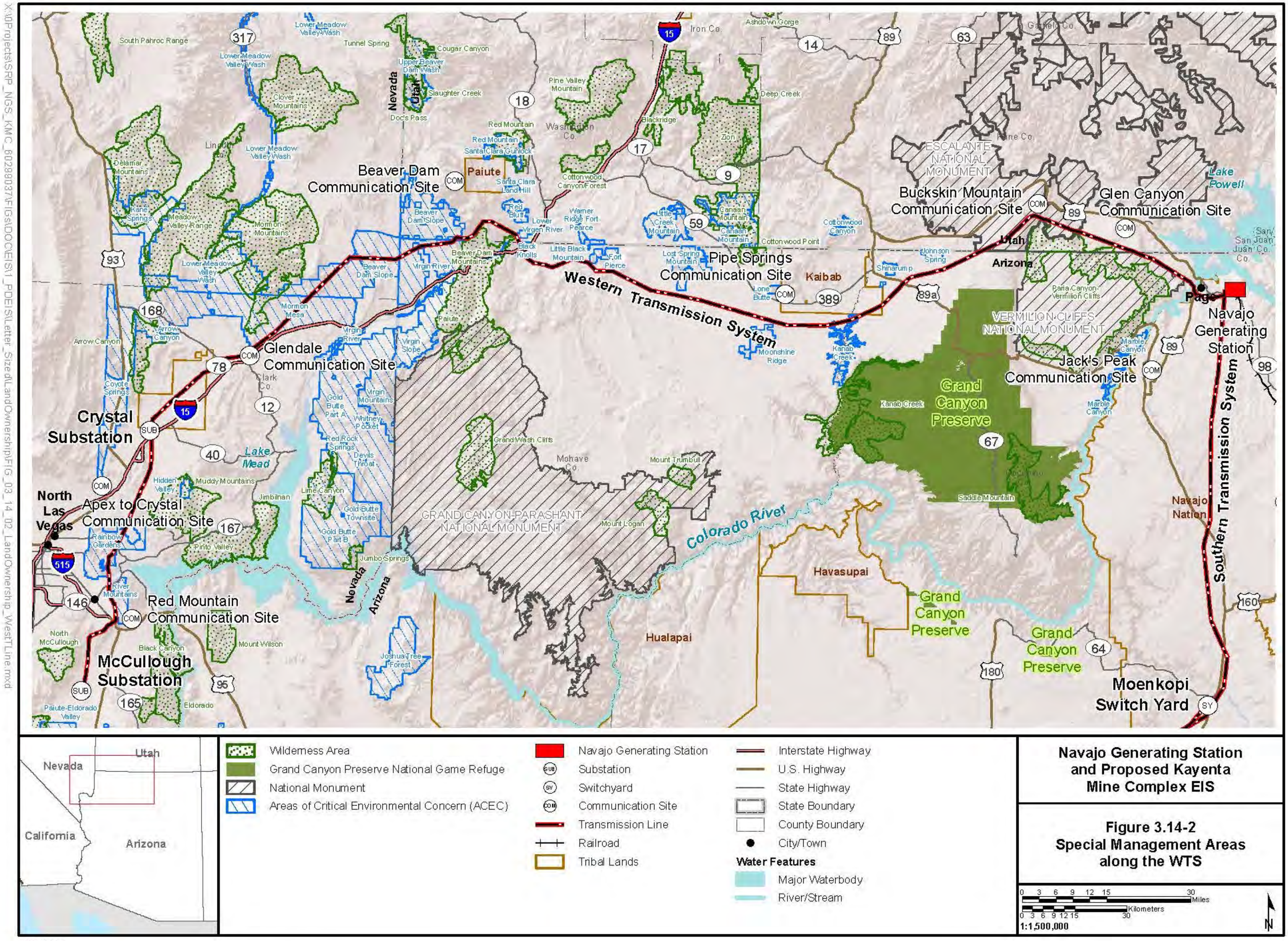


Figure 3.14-2
Special Management Areas along the WTS

Seven special BLM designation areas are intersected by the WTS ROW.

1. Beaver Dam Slope ACEC. This ACEC encompasses a total of 136,616 acres in Arizona (51,197 acres), Nevada (36,900 acres), and Utah (48,519 acres). In Mohave County, the WTS crosses 10 miles of the ACEC, which was designated in the 2008 Arizona Strip RMP to protect desert tortoise and Mojave Desert ecological zone values. The ACEC was designated after construction of the WTS. The RMP also designated a utility corridor within which the WTS is located. Areas outside the designated corridor are considered ROW avoidance areas. The ACEC also extends southwest into Lincoln County, Nevada; that portion is managed under the Ely District RMP.
2. Kanab Creek ACEC. This ACEC encompasses 13,148 acres and was designated to protect habitat for the endangered southwestern willow flycatcher, riparian and scenic values, and cultural resources. It also provides habitat for desert bighorn sheep.
3. Lower Virgin River ACEC. This ACEC encompasses 1,822 acres along the Virgin River just north of the Utah/Arizona state line and was managed to improve and maintain riparian habitat for the endangered woundfin minnow and Virgin River chub, and provide habitat for various migratory and non-game birds as well as protecting numerous cultural rock art sites of the Anasazi and Southern Paiute tribes.
4. Mormon Mesa ACEC. This ACEC encompasses 151,360 acres and was designated to protect desert tortoise and desert tortoise habitat. It is managed by BLM under the Ely District RMP and Las Vegas RMP. The WTS was built prior to designation of the ACEC and falls within a designated utility corridor. Under the Las Vegas RMP, the WTS corridor is managed as an exclusion area for site-type ROWs except within 0.5 mile of federal highway centerlines.
5. Rainbow Gardens ACEC. This 37,620-acre ACEC was designated for its cultural, geologic, scenic, and sensitive plant values. It contains the Great Unconformity, an area where intervals of the geologic record are missing. It contains cultural resources and a gypsum cave. The ACEC is managed by BLM under the Las Vegas RMP as a linear and site-type ROW avoidance area except within designated corridors.
6. River Mountains ACEC. This 5,617-acre ACEC is managed to protect habitat for the River Mountains desert bighorn sheep as well as for the viewshed it provides for the residents of Henderson and Boulder City, Nevada. It is managed by BLM under the Las Vegas RMP as a linear and site-type ROW avoidance area except within designated corridors.
7. Grand Staircase-Escalante National Monument. This national monument covers 1.9 million acres and was designated after construction of the WTS. It contains valued biological and geological resources.

The WTS passes through a ROW corridor administered by the BLM (labeled Moapa Corridor) that traverses the Moapa River Indian Reservation. This ROW corridor is administered as Indian trust lands as established pursuant to Public Law 96-491. Vegetation treatments are not routinely conducted along the ROW because the associated vegetation communities tend to be sparse and low growing. Clearing typically is not necessary and is conducted on an as-needed basis.

Two substations (Crystal and McCullough) are connected to the WTS and contain power transformers, switching devices, and circuit breakers and disconnects.

- The Crystal Substation is located less than 1 mile south of the Moapa Indian Reservation, and approximately 20 miles northeast of Nellis Air Force Base in Clark County, Nevada, on 284 acres of BLM-managed land.
- The McCullough Substation is located approximately 14 miles southwest of Boulder City in Clark County, Nevada, on 253 acres of BLM managed land.

The communication sites listed in **Table 3.14-4** associated with the WTS have little influence on land use because they are either collocated with other facilities, in the transmission ROW, or are in remote locations and occupy very little space (less than 1 acre).

The WTS ROW runs in an east-west direction through northern Arizona, southwest Utah, and southeast Nevada and primarily is located on BLM-managed lands. This area is sparsely populated with the exception of St. George, Utah, and southern Nevada in the vicinity of Las Vegas, Henderson, and Boulder City.

The WTS intersects with 40 BLM managed grazing allotments for a total of approximately 169 miles (118 miles in Arizona, 32 miles in Utah, and 19 miles in Nevada), in all intersected counties except Clark County, Nevada.

3.14.3.3.1.2 Recreation

The WTS crosses the southern portion of Glen Canyon National Recreation Area before heading northwest into Utah. Recreational activities there would be the same as discussed for the NGS. In Utah the WTS passes through Grand Staircase-Escalante National Monument and skirts the northern edge of Vermilion Cliffs National Monument adjacent to the Paria Canyon Wilderness and the western portion of Lower Virgin River ACEC and the northern portion of Beaver Dam Mountains Designated Wilderness. The Lower Virgin River ACEC receives a high level of recreational use. The Beaver Dam Mountains Designated Wilderness offers recreationists the opportunity to raft or kayak in the Virgin River, or hike, backpack, view wildlife, and star gaze. The WTS ROW also crosses through Beaver Dam Slope ACEC in the northwest corner of Arizona and Mormon Mesa ACEC in eastern Nevada. Both areas are managed to provide and protect critical habitat for desert tortoise. In southern Nevada, the WTS ROW passes through Rainbow Gardens ACEC and River Mountains ACEC. Rainbow Gardens is a scenic mountain and canyon landscape that allows recreationists the opportunity to experience a wilderness setting while still being close to Las Vegas. River Mountain ACEC is managed to protect habitat for the River Mountains desert bighorn sheep as well as for the viewshed it provides for the residents of Henderson and Boulder City.

3.14.3.3.2 Southern Transmission System

3.14.3.3.2.1 Land Use

The STS is a 256-mile ROW that contains two parallel transmission lines originating at the NGS and terminating at the Westwing Substation approximately 20 miles northwest of Phoenix (**Figure 3.14-3** and **Figure 1-14**). The STS consists of two 500-kV transmission lines (the eastern line is the Westwing line and the western line is the Moenkopi line), the Moenkopi Switchyard, and five substations. There is a portion of the ROW near Moenkopi where the two lines do not share a common ROW. The entire ROW is within the State of Arizona and passes through Coconino, Yavapai, and Maricopa counties. The ROW passes through multiple jurisdictions (**Table 3.14-3).**

The Moenkopi Switchyard is located off U.S. Highway 89 in Coconino County. It is approximately 25 acres and is contained within the existing Four Corners Power Plant transmission line ROW. It contains a control house, storage building, and a 1,000-gallon diesel tank. Four transmission lines are connected via the Moenkopi Switchyard. They are the Four Corners to Moenkopi line, the NGS to Moenkopi line, the Moenkopi to Eldorado Substation line, and the Moenkopi to Yavapai Substation line.

Vegetation treatments are conducted along the ROW according to the ROW easement agreement and BLM and Forest Service corridor management plans.

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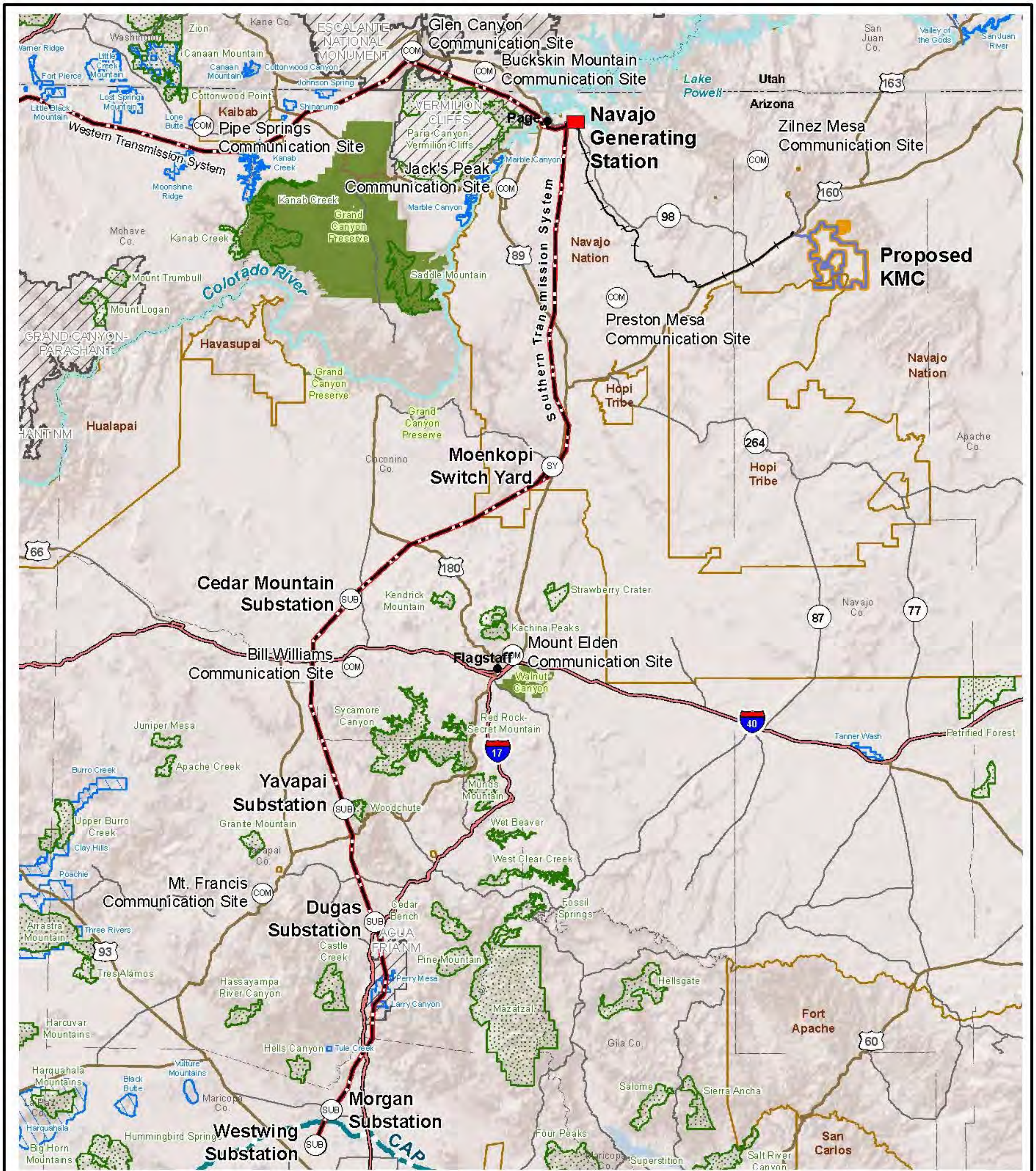

Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 3.14-3 Special Management Areas along the STS

7/19/2016

Five substations (Cedar Mountain, Yavapai, Dugas, Morgan, and Westwing) interconnect to the STS and contain similar components as those along the STS.

- The Cedar Mountain Substation is located approximately 11 miles north of the City of Williams in Coconino County on 15 acres of private land.
- The Yavapai Substation is located approximately 12 miles north of Prescott Valley in Yavapai County on 21 acres of U.S. Forest Service land.
- The Dugas Substation is located approximately 6 miles east of the City of Mayer in Yavapai County on 69 acres of state land.
- The Morgan Substation is located approximately 0.5 mile south of Arizona State Route 74 and 0.75 mile east of the Aqua Fria River in Maricopa County on 4 acres of state land.
- The Westwing Substation is the terminal point of the STS and is located approximately 3 miles northeast of Sun City West in Maricopa County on 14 acres of state land.

Similar to the communication sites discussed for the WTS, the 10 communication sites that service the STS (**Table 3.14-3**) have little influence on land use because they are either located in the transmission line ROW or are in remote locations and occupy very little (1 acre or less) space.

The STS ROW runs in a north-south direction through the western portion of the Navajo Nation. This area is sparsely populated and consistent with the discussion for NGS and the proposed KMC. South of the Navajo Nation, the STS passes through the Kaibab and Prescott National Forests and Aqua Fria National Monument, all of which attract local visitors and tourists for the recreational resources they provide. The STS passes through both national forests within the designated West Wide Energy Corridor (West Wide Energy Corridor 2015). Both forests are managed according to their respective LRMPs. The counties crossed by the STS include Coconino, Yavapai, and Maricopa (all within Arizona). No issues with the STS were identified within the Comprehensive County Plans for these counties. Additionally, within Maricopa County the New River Community has produced an area plan that was adopted in 1999. Similarly, no issues with the STS were identified within the area plan.

The STS intersects with 16 BLM managed grazing allotments for a total of approximately 51 miles, all of which are located south of Interstate 40. It is likely that the STS passes through lands used for livestock grazing on the Navajo Nation. No grazing allotments are crossed in the Kaibab or Prescott National Forests.

Two special BLM designation areas are intersected by the STS ROW: Perry Mesa ACEC and Aqua Fria National Monument. The ROW passes through approximately 9 miles of the Perry Mesa ACEC, which is located within Aqua Fria National Monument. The ACEC is a wilderness unit of approximately 16,775 acres with the Aqua Fria River defining its western border. Archaeological resources within the Perry Mesa ACEC are one of the primary factors for designating the Aqua Fria National Monument. The Aqua Fria National Monument is 70,900 acres located approximately 40 miles north of Phoenix. It is managed to offer a variety of recreational, research, and educational opportunities. The ROW passes through approximately 31 miles of the National Monument. The Perry Mesa ACEC and Aqua Fria National Monument are discussed further in the Recreation sub-section.

3.14.3.3.2.2 Recreation

Recreational resources and activities for the northern portion of the STS within the Navajo Nation are similar to the discussion for the NGS and associated facilities (excluding Lake Powell). The southern portion of the STS passes through the Kaibab and Prescott National Forests and Aqua Fria National Monument. The ROW is located approximately 10 miles to the west of the Sycamore Canyon and Pine Mountain wilderness areas within the forests. Recreational activities in the forest include camping, fishing, hang gliding, hiking, horseback riding, off-highway vehicle use, picnicking, and photography. The

ROW passes through the central portion of Aqua Fria National Monument and Perry Mesa ACEC on BLM-managed land. Visitor activities in the National Monument and ACEC include camping, hiking, hunting, scenic and four-wheel drives, and viewing and photographing cultural sites and wildlife.

3.14.4 Environmental Consequences

3.14.4.1 Issues

The issues of concern received during project scoping are listed below. Almost all of the issues identified through public scoping, except disposal of fly ash, are related to the proposed KMC. A description of the impact analysis methods follows.

3.14.4.1.1 Land Use

- Disposal of fly ash;
- Displacement of residents from their traditional lands and compensation by agreements between PWCC and tribal governments;
- Intended purpose and use of reclaimed lands (livestock grazing, wildlife habitat, cultural plants, etc.);
- Constraints to the use of reclaimed lands;
- Need for improvement of reclamation monitoring and success;
- Realignment and reclamation of Navajo Route 41; and
- Opposition to incorporating the former Black Mesa Mine area into the proposed KMC.

3.14.4.1.2 Recreation

- Dispersed recreation on Navajo and Hopi lands; recreation impacts to tribal- and federally managed lands; and
- Reduced enjoyment of recreation areas due to visible haze attributed to emissions from the power plant.

3.14.4.2 Assumptions and Impact Methodology

3.14.4.2.1 Land Use

Land Use Plans and RMPs were used to determine land use constraints and allowed uses on the lands under federal and Navajo Nation jurisdiction. These sources included applicable Navajo Chapter land use plans when available, the Aqua Fria RMP Record of Decision (2010); Prescott National Forest Land and Resource Management Plan (1986); Arizona Strip, Grand Canyon-Parashant, and Vermilion Cliffs Monuments Final Environmental Impact Statement and Record of Decision (2007 and 2008, respectively); the Ely District RMP Final Environmental Impact Statement and Record of Decision (2008); and the Las Vegas RMP Final Environmental Impact Statement and Record of Decision (1998). In addition, information from the Navajo Nation Parks and Recreation Department, the Navajo Nation Hospitality Enterprise, and the National Park Service (Glen Canyon NRA General Management Plan) were used in the discussions regarding land use on Navajo Nation and National Park Service lands.

Surface disturbance at the proposed KMC is defined by coal resource area. The difference in surface disturbance for the 2-Unit Operation is calculated based on the percentage of reduction to the annual tonnage of coal removed compared to the 3-Unit Operation. Land use agreements were analyzed using relevant PWCC permit packages and revisions submitted to the OSMRE. Current reclamation status was analyzed using the annual reports (2002 through 2014) prepared by PWCC.

3.14.4.2.2 Recreation

Recreational resources impacts were determined by analysis of documents and data produced by the Navajo Nation Parks and Recreation Department, the Navajo Nation Hospitality Enterprise, and the National Park Service.

3.14.4.3 Proposed Action

3.14.4.3.1 Navajo Generating Station

3.14.4.3.1.1 Land Use

Under the Proposed Action, the NGS and associated facilities, including the BM&LP Railroad, would continue to operate from 2020 through 2044. This analysis considers two different NGS operation conditions to capture the full range of the Proposed Action. The 3-Unit Operation would be the generation of 2,250 megawatts (MW) of power with air emission controls installed as described in Chapter 2.0. The 2-Unit Operation would be the generation of 1,500 MW of power with additional air emission controls and one less generating unit in operation as described in Chapter 2.0.

Onsite impacts to land use would be similar for either operation; however, there would be 239 acres of new surface disturbance for the 3-Unit Operation compared to 199 acres of new disturbance for the 2-Unit Operation. The 80-mile BM&LP Railroad would remain in place, traversing from the proposed KMC to the NGS site; all within the Navajo Nation.

The ash landfill would be increased by 40 acres within its existing footprint to accommodate the volume of ash disposal needed for 3-Unit Operation. The current size of the landfill is sufficient for 2-Unit Operation. The land committed for the asbestos disposal and ash disposal areas would continue to be used as discussed in Section 3.14.3.1.

The amount of solid waste likely would not change and would continue to be disposed of off-site. The volume of water needed from Lake Powell would be reduced from 29,000 acre-feet per year to 19,000 acre-feet per year under the 2-Unit Operation.

Surface disturbance related to decommissioning would not occur until decommissioning begins and would not disturb any land outside of the NGS site boundary or the BM&LP Railroad ROW (**Appendix 1B**). Unless NGS operations are continued by the Navajo Nation beyond 2044, the majority of the structures would be dismantled and demolished to ground level by December 22, 2045. Structures that would be retained, per the 1969 Lease and Lease Amendment No. 1 terms with the Navajo Nation, include the following:

- Lake Powell pump station, both suction lines, discharge lines, power supply lines, communication facilities, and roads along the pipelines;
- Administration building;
- Warehouse;
- Machine shop building;
- Visitor's building;
- Automotive maintenance building;
- Electric shop;
- Welding shop;
- Coal crusher building;
- Roads and fences;

- Switchyards; and
- 500-kV transmission lines and associated facilities.

Major components that would be demolished include the boiler, turbine, and chimneys. With the exception of hazardous materials and materials recycled, salvaged, or sold as scrap, the demolished material would be buried in an onsite landfill.

Criteria for adequate closure of the asbestos and ash landfills likely would require a final cover system designed to minimize infiltration and erosion. SRP likely would be required to install and maintain a final cover system, leachate collection system, and groundwater monitoring system. More information regarding the closure of the ash land fill can be found in **Appendix 1B**, Navajo Generating Station: Coal Combustion residuals Ash Disposal Landfill Requirements. Neither landfill would be used for the disposal of demolished infrastructure that would be buried at the NGS site.

The BM&LP Railroad also would be decommissioned. This would include the removal of all overhead lines, rails, ties, and ballast. Railroad embankments, culverts, and overpasses would be abandoned in place and the 80-mile-long ROW would be returned to the Navajo Nation as closely as possible to original condition.

Under the Proposed Action, approximately 199 to 239 acres of new surface disturbance would occur within the NGS boundary and the 80-mile BM&LP Railroad would remain in place and operational. The ash landfill would increase by 80 acres within the landfill boundary and the asbestos landfill would continue to be utilized.

3.14.4.3.1.2 Recreation

Recreation is affected by the visual presence of NGS. As the facility currently exists, its continued operation would constitute a negligible impact to recreation activities. Under the Proposed Action, visual impact of the plant would cease in 2045 when the site is decommissioned.

3.14.4.3.2 Proposed Kayenta Mine Complex

3.14.4.3.2.1 Land Use

Under the Proposed Action 3-Unit Operation, mining would occur in the N-10, N-11 Ext, and J-21-W areas, as well as portions of the N-9, J-19, and J-21 areas resulting in 5,230 acres of surface disturbance. The 2-Unit Operation would require less coal from the proposed KMC and coal resource area N-10 would not be mined; reducing the potential land disturbance at the proposed KMC by approximately 490 acres.

Under the 3-Unit Operation, an estimated eight residential relocations would occur, under the 2-Unit Operation mining would not occur in the N-10 area, potentially eliminating the need for two residential relocations.

A total of six assigned grazing areas also would be incrementally reduced or eliminated, pending final reclamation, under the 3-Unit Operation; for the 2-Unit Operation, four grazing areas would be reduced or eliminated, pending final reclamation. Most of the reclaimed mine areas now provide a greater amount of forage vegetation than was available under pre-mine conditions. Vegetation monitoring on reclaimed lands has indicated a downward trend in vegetation composition and health due to overgrazing in some areas. A temporary moratorium on grazing reclaimed lands has been placed until conditions improve. Future reclamation would continue to contribute to successful grazing and appropriate management. Ongoing monitoring and possible reseeding in areas that are less responsive to reclamation may be required. The reduction in the number of available grazing areas would be considered a minor impact because the loss of these four to six grazing areas may be partially or completely offset by increased forage created by the reclamation that has occurred on previously mined areas.

The resulting grassland communities would increase the livestock carrying capacity and improve the potential for grazing management (OSMRE 2011). The post mining uses of the reclaimed areas would be similar to pre-mining uses, including production of forage for grazing, wildlife habitat, and collection of culturally important plants (Section 3.8.).

The reclaimed areas would provide habitat for species adapted to habitat edges, early successional environments, and grassland habitats. Species that are highly adaptable could increase in abundance in reclaimed areas. These species include deer, elk, deer mice, Ord's kangaroo rats, Gunnison's prairie dogs, Navajo mountain vole, black-tailed jackrabbits, desert cottontails, red foxes, coyotes, some bats, eastern fence lizards, prairie falcons, and red-tailed hawks. In the long-term, the breeding potential for most raptors could increase as trees develop in portions of the reclaimed areas (see Section 3.10). Under the Proposed Action PWCC is proposing to leave 51 ponds available as water sources for livestock and wildlife (Section 3.14.3.2). All ponds would meet permanent pond design criteria (PWCC 2012 et seq.).

The realignment of Navajo Route 41 to its original location in two places south of mine area J-3 would eliminate some sharp turns, resulting in minor impacts due to improved road safety.

Several scoping comments indicated that some Navajo and Hopi people would prefer that the Black Mesa Mine be reclaimed and returned to the Navajo Nation and Hopi tribe rather than becoming part of the proposed KMC. Under all action alternatives, creation of the proposed KMC would constitute a major impact due to the length of time before the lands would revert to tribal governance.

3.14.4.3.2.2 Recreation

Recreational activities within the proposed KMC area consist of a very limited amount of dispersed activities. Most dispersed recreation on Black Mesa occurs to the north of the proposed KMC; however, mining activities under the Proposed Action could disrupt the recreational setting under either of the production scenarios until reclamation is complete. Impacts to recreation on the proposed KMC are negligible because the mine disturbance is a small percentage of the available area that provides opportunity for dispersed activities.

3.14.4.3.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

There would be no new impacts to land use and recreation because operation and maintenance for the existing WTS, STS, and communication sites would not change under the Proposed Action.

3.14.4.3.4 Project Impact Summary – All Project Components

Impacts to land use would occur only at the proposed KMC because none of the other components would expand beyond their current boundaries. The proposed KMC would not expand beyond the permit boundary; however, post-2019 mining would result in residential relocations. Residential relocations are considered to be a moderate impact because a compensation program is in place; however, the residents would be removed from their family lands and it is unknown if they would return. Continued mining at the proposed KMC would result in an incremental reduction or removal of four to six grazing areas. This impact would be considered minor because the vegetation in reclaimed areas is of higher forage value, offsetting the reduction in number of grazing areas. The current moratorium on grazing would be considered a moderate impact for the individuals it would affect because they would either have to stop grazing livestock or arrange for grazing elsewhere.

Proposed KMC impacts to recreation also are considered negligible because very little dispersed recreation occurs in area. The WTS and STS would not impact recreation because operations are not anticipated to change.

The BM&LP Railroad operations would not change under the 3-Unit Operation and would make fewer trips to and from the NGS under the 2-Unit Operation incrementally reducing the probability of accidents with livestock, wildlife, and vehicles. Operation of the WTS and STS is not dependent on the NGS and proposed KMC continued operations and would continue as permitted for the duration of the ROW grant/permit period. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

3.14.4.3.5 Cumulative Impacts

3.14.4.3.5.1 Navajo Generating Station

No reasonably foreseeable future actions (RFFAs) are anticipated that would result in cumulative impacts to land use. All surface disturbances would be confined to the existing NGS plant site and the existing railroad ROW as a continuation of operations. No RFFAs would enlarge the footprint of these facilities.

No RFFAs were identified for recreation. Cumulative impacts for land use and recreation would be none to negligible.

3.14.4.3.5.2 Proposed Kayenta Mine Complex

No RFFAs were identified. Future surface disturbance would be conducted on the proposed KMC in the mine areas previously identified.

3.14.4.3.5.3 Transmission Systems and Communication Sites

The TransWest Express, Southern Nevada Intertie, and Eastern Nevada transmission lines may be constructed in an existing West-Wide ROW adjacent to the WTS from the vicinity of Mesquite to the Eldorado Valley south of Las Vegas, Nevada (**Figure 3.0-3**). Segments of the Lake Powell water pipeline and transmission line are proposed to overlap with the WTS utility corridor in Coconino County, Arizona west of Lake Powell (**Figure 3.0-2**). Cumulative impacts for land use and recreation would be negligible.

3.14.4.4 Natural Gas Partial Federal Replacement Alternative

Under the Natural Gas Partial Federal Replacement (PFR) Alternative, a selected quantity of power between 100 megawatts (MW) and 250 MW would be contracted for under a long-term power purchase agreement from currently unidentified, existing natural gas generation sources, displacing an equivalent amount of power from the federal share of NGS generation. Because the facility is assumed to currently exist, prior disturbance impacts to land use and recreation are not evaluated.

3.14.4.4.1 Navajo Generating Station

Although there would be a reduction to the amount of energy produced, impacts to land use at the NGS would be negligible because operations would continue within the same established boundary and ROWs. For the same reason, there would be negligible impacts to recreational opportunities and quality.

3.14.4.4.2 Proposed Kayenta Mine Complex

Impacts to land use are expected to be similar to those described for the Proposed Action 3-Unit Operation and 2-Unit Operation because it is assumed mining would occur in the same areas but at a reduced rate. This would result in 4,968 or 3,888 acres of surface disturbance for 3-Unit Operation and 2-Unit Operation, respectively.

Impacts to recreation are considered negligible, the same as those described for the Proposed Action, as mining activities would continue to dominate this portion of the Black Mesa area.

3.14.4.4.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance. Impacts to land use and recreation from ongoing operation of the transmission lines and communication sites are considered negligible.

3.14.4.4.4 Project Impact Summary – All Project Components

Although energy production at the NGS, coal production at the KMC and deliveries of the BM&LP Railroad would decrease, impacts to land use and recreation would be less than the Proposed Action, which were considered to be negligible.

3.14.4.4.5 Cumulative Impacts

Cumulative impacts would be the same as described for the Proposed Action.

3.14.4.5 Renewable Partial Federal Replacement Alternative

Under the Renewable PFR Alternative, a selected quantity of power between 100 MW and 250 MW would be contracted for under a long-term power purchase agreement from a currently unidentified, existing renewable energy power source, displacing an equivalent amount of power from the federal share of NGS generation.

3.14.4.5.1 Navajo Generating Station

There would be a reduction to the amount of energy produced at the NGS under the Natural Gas PFR. Impacts to land use at the NGS would be negligible because operations would continue within the same established boundary and ROWs. As operation of the NGS would not be substantially changed under this alternative compared to the Proposed Action, there would be negligible impacts to recreational opportunities or quality.

3.14.4.5.2 Proposed Kayenta Mine Complex

Impacts to land use are expected to be similar to those described for the Proposed Action 3-Unit Operation and 2-Unit Operation because mining would occur in the same areas but at a reduced rate. Less coal would be mined compared to the Proposed Action resulting in 5,072 and 4,267 acres of surface disturbance for 3-Unit Operation and 2-Unit Operation, respectively.

Impacts to recreation would be the same as those described for the Proposed Action as mining activities would still dominate this portion of the Black Mesa area.

3.14.4.5.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance. Impacts to land use and recreation from ongoing operation of the transmission lines and communication sites are considered negligible.

3.14.4.5.4 Project Impact Summary – All Project Components

Impacts to land use and recreation would be negligible; however, approximately 3 to 11 percent less surface disturbance at the propose KMC would occur due to reduction in coal mined for this alternative.

3.14.4.5.5 Cumulative Impacts

Cumulative impacts would be the same as described for the Proposed Action.

3.14.4.6 Tribal Partial Federal Replacement Alternative

Under the Tribal PFR Alternative, between 100 MW and 250 MW of power generation from the NGS would be replaced by power supplied by a new photovoltaic generation facility on tribal land, displacing an equivalent amount of power from the federal share of NGS generation. The construction of a new photovoltaic generation site on tribal land would result in between 1,200 and 3,000 acres of new surface disturbance. The Tribal PFR facility would be analyzed in a separate NEPA process once a facility location is identified.

3.14.4.6.1 Navajo Generating Station

There would be a reduction to the amount of energy produced at the NGS under the Tribal PFR. Impacts to land use at the NGS would be negligible because operations would continue within the same established boundary and ROWs. As operation of the NGS would not be substantially changed under this alternative compared to the Proposed Action, there would be negligible impacts to recreational opportunities or quality.

3.14.4.6.2 Proposed Kayenta Mine Complex

Impacts to land use are expected to be similar to those described for the Proposed Action 3-Unit Operation and 2-Unit Operation but resulting in 5,124 or 4,409 acres of surface disturbance, respectively. Although less coal would be mined under both Tribal PFR Alternative operations compared to the Proposed Action, it is assumed mining would occur in the same areas but at a reduced rate. This would result in the same number of residential relocations and loss of grazing areas per operation.

Impacts to recreation would be the same as those described for the Proposed Action as mining activities would still dominate this portion of the Black Mesa area.

3.14.4.6.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance. Impacts to land use and recreation from ongoing operation of the transmission lines and communication sites are considered negligible.

A tie-line from the Tribal PFR facility or facilities to connect to the WTS or STS may be required, however, construction would be authorized as a separate project under a subsequent NEPA action.

3.14.4.6.4 Project Impact Summary – All Project Components

Impacts to land use and recreation would be negligible, however approximately 2 to 17 percent less surface disturbance would occur due to reduction in coal mined for this alternative. The potential exists, if this alternative is selected, for a variety of impacts to land use on tribal lands related to construction and connecting a new photovoltaic generation site on tribal land to the existing transmission system, which would require subsequent NEPA evaluation.

3.14.4.6.5 Cumulative Impacts

Cumulative impacts would be the same as described for the Proposed Action except for the construction of a photovoltaic facility and associated transmission lines.

3.14.4.7 No Action Alternative

3.14.4.7.1 Navajo Generating Station

Under the No Action Alternative, operation of the NGS would cease at the end of 2019. Consistent with the requirements of the 1969 Lease, the Lessees would undertake decommissioning activities (see Section 2.3.3.1). Structures within the plant site would be demolished to ground level with the exception of water supply facilities and some buildings in accordance with the lease agreement terms (Section 3.14.4.3). Demolished structures largely would be buried in place.

The BM&LP Railroad also would be decommissioned. This would include the removal of all overhead lines, rails, ties, and ballast. Railroad embankments, culverts, and overpasses would be abandoned in place and the 80-mile-long ROW would be returned to the Navajo Nation. The NGS site, including the BM&LP Railroad ROW would be returned to the Navajo Nation approximately 25 years earlier than under the Proposed Action.

The quality of recreational activities at Lake Powell and Glen Canyon would cease to be influenced by the view of the structures at the plant site once decommissioning is complete. It is possible that closure of the plant could result in some personnel no longer employed by SRP moving to other areas with associated impacts to local recreation businesses. This would be considered a negligible to minor impact because the number of NGS employees is small (approximately 490 workers) compared to the large number of visitors to the area. The impact of losing recreational spending from those employees, with the possible exception of some smaller “niche” businesses, would likely not be recognized by a 1.5 billion dollar industry (Section 3.18).

3.14.4.7.2 Proposed Kayenta Mine Complex

Mining at the proposed KMC would cease at the end of 2019. Final reclamation would commence approximately 25 years sooner than it would under the Proposed Action, and structures not approved as permanent facilities would be removed. No additional residents would be relocated. The ponds that have been constructed at that time would remain in place for livestock water sources.

Dispersed recreational activities on Black Mesa would include the reclaimed areas within the proposed KMC area. Local and transient wildlife populations may increase due to the lack of mining disturbance and successful reclamation.

3.14.4.7.3 Transmission Systems and Communication Sites

The NGS transmission system is an established part of the western U.S. transmission grid and supports reliability and delivery of power throughout the region, well beyond the power generated by the NGS. Therefore, under the No Action Alternative it is likely that that one, several, or all of the land owners/managers of the transmission line rights-of-way and communication site leases would renew some portion of the facilities to keep the power grid performing as expected.

In the event it is determined that some or all of the transmission systems and communication site ROWs are not renewed, a lengthy study and permitting process would need to occur before any decommissioning is initiated due to the essential and integral nature of these facilities with the western electric grid. As noted in Section 2.3.3, up to 4,826 acres within and alongside the transmission system corridors could be temporarily disturbed if the entirety of the transmission systems and communication sites were decommissioned and removed.

3.14.4.7.4 No Action Impact Summary – All Project Components

Once decommissioning and reclamation activities are complete, the NGS site, BM&LP Railroad ROW, and proposed KMC totaling 29,672 acres, would be returned to the Navajo Nation and Hopi Tribe approximately 25 years earlier than under the Proposed Action.

Impacts to recreation from the No Action Alternative would be none to negligible as the areas comprising the NGS and proposed KMC currently are not open to public recreation activities and the closure of those facilities would not change recreational opportunities in the area. If the closure of the NGS plant and potential out-migration of some displaced workers does have a negative effect to the recreational business in the area it would be considered a minor impact due to the relatively small number of people affected.

Operation of the WTS and STS is not dependent on the NGS and proposed KMC continued operations and would continue as permitted for the duration of the ROW grant/permit period. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

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Section 3.15

Public Safety

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Acronyms and Abbreviations

1969 Lease	Navajo Project Indenture of Lease
BART	Best Available Retrofit Technology
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BM&LP Railroad	Black Mesa & Lake Powell Railroad
BO	Biological Opinion
CAP	Central Arizona Project
CCR	Coal combustion residual
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CO_2	carbon dioxide
Co-tenants	Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
dBA	decibels on the A-weighted scale
Development Fund	Lower Colorado River Basin Development Fund
EIS	Environmental Impact Statement
ERA	Ecological Risk Assessment
ESA	Endangered Species Act of 1973
HHRA	Human Health Risk Assessment
km	kilometer
KMC	Kayenta Mine Complex
kV	kilovolt
kW	kilowatt
MW	megawatt
N-Aquifer	Navajo Aquifer
NEPA	National Environmental Policy Act of 1969, as amended
NGS	Navajo Generating Station
NGS Participants	U.S. (Reclamation), Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
NHPA	National Historic Preservation Act
NNEPA	Navajo Nation Environmental Protection Agency
NO_2	nitrogen dioxide
NO_X	nitrogen oxide
OSHA	Occupational Safety and Health Administration
OSMRE	Office of Surface Mining Reclamation and Enforcement
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 microns or less
PFR	Partial Federal Replacement

PWCC	Peabody Western Coal Company
Reclamation	U.S. Bureau of Reclamation
RCRA	Resource Recovery and Conservation Act
ROW	Right-of-way
SO_2	sulfur dioxide
SRP	Salt River Project Agricultural Improvement and Power District
STS	Southern Transmission System
U.S.	United States
USDOT	U.S. Department of Transportation
USEPA	U.S. Environmental Protection Agency
WTS	Western Transmission System

Contents

3.15 Public Safety ... 3.15-1
3.15.1 Regulatory Framework ... 3.15-1
3.15.1.1 Public Safety ... 3.15-1
3.15.1.2 Industrial Noise ... 3.15-1
3.15.1.3 Hazardous Materials ... 3.15-2
3.15.1.4 Solid Waste ... 3.15-3
3.15.2 Study Areas ... 3.15-3
3.15.2.1 Proposed Action and Action Alternatives ... 3.15-3
3.15.2.2 Cumulative ... 3.15-4
3.15.3 Affected Environment ... 3.15-4
3.15.3.1 Navajo Generating Station ... 3.15-6
3.15.3.2 Proposed Kayenta Mine Complex ... 3.15-10
3.15.3.3 Transmission Systems and Communication Sites ... 3.15-13
3.15.4 Environmental Consequences ... 3.15-15
3.15.4.1 Issues ... 3.15-15
3.15.4.2 Assumptions and Impact Methodology ... 3.15-15
3.15.4.3 Proposed Action ... 3.15-16
3.15.4.4 Natural Gas Partial Federal Replacement Alternative ... 3.15-25
3.15.4.5 Renewable Partial Federal Replacement Alternative ... 3.15-27
3.15.4.6 Tribal Partial Federal Replacement Alternative ... 3.15-29
3.15.4.7 No Action ... 3.15-31
3.15.5 References ... 3.15-32

List of Tables

Table 3.15-1 OSHA Workplace Permissible Noise Exposures 3.15-1
Table 3.15-2 Major Bulk Chemical and Product Deliveries to NGS 3.15-8
Table 3.15-3 Annual Off-site Solid Waste Volume and Disposition 3.15-9
Table 3.15-4 CCR Disposal in 2014 .... 3.15-10
Table 3.15-5 Noise Levels at Various Distances from Typical Mining Equipment 3.15-11
Table 3.15-6 Major Bulk Chemical and Product Deliveries to Kayenta Mine 3.15-13
Table 3.15-7 Noise and Average Electric and Magnetic Field Strengths at Study Area Edge 3.15-14
Table 3.15-8 Potential Transportation Incidents During Transportation of Chemicals and Products 3.15-19

List of Figures

Figure 3.15-1 Typical A-weight Sound Levels 3.15-5

3.15 Public Safety

For purposes of this analysis, Section 3.15, Public Safety, addresses the risks of direct public exposure to operational activities (e.g., blasting with potential noise and vibration effects), hazards associated with transportation of hazardous materials, and railway and transportation safety. Refer to Section 3.16, Public Health, which primarily focuses on the potential consequences of indirect effects of individual exposures to power plant and/or mine operations (e.g., airborne pollutants, noise, etc.), and the associated human health risks.

3.15.1 Regulatory Framework

3.15.1.1 Public Safety

The Navajo Generating Station (NGS) and associated facilities are located on Navajo Nation tribal trust land, and the proposed Kayenta Mine Complex (KMC) is located on Navajo Nation and Hopi tribal trust lands. The proposed KMC is subject to tribal laws and regulations, as well as federal regulations; however, the operation of NGS is not subject to tribal laws and regulations per a 'Covenant Not to Regulate' in the 1969 lease. The U.S. Environmental Protection Agency (USEPA) provides continuing oversight for major federal environmental programs, including the transport and storage of hazardous materials and waste. Bulk products and chemicals, including petroleum products, are delivered to the NGS and the Kayenta Mine over the public highway system. The State of Arizona has no jurisdiction over public safety at the NGS and associated facilities (located on the Navajo Reservation) or the proposed KMC.

The Occupational Safety and Health Administration (OSHA) and Mine Safety Health Administration would oversee worker safety at NGS and the proposed KMC, respectively. Agencies that are involved in the regulation of hazardous materials and solid waste include U.S. Department of Transportation (USDOT), Arizona Department of Transportation, and Arizona Department of Environmental Quality. An evaluation of worker safety is outside the scope of this Environmental Impact Statement.

3.15.1.2 Industrial Noise

The U.S. Department of Labor's OSHA has jurisdiction over most occupational health and safety issues within the state. Industrial construction and routine workplace operations are governed by the OSHA standards of 1970, particularly 29 Code of Federal Regulations (CFR) Part 1910 (general industry standards). The Mine Safety Health Administration provides regulatory guidance on mining workplace safety thresholds, specifically the Mine Safety Health Administration standards of 1977. Evaluation of worker safety is not within the scope of this Environmental Impact Statement, but some USEPA standards are applicable to public safety, particularly residences located in proximity to active mining.

The USEPA Noise Control Act of 1972 indicates that a 24-hour equivalent level of less than 70 decibels on the A-weighted scale (dBA) prevents hearing loss and that a level below 55 dBA, in general, does not constitute a major impact. **Table 3.15-1** details the workplace protection measures provided per OSHA guidance against the effects of noise exposure.

Table 3.15-1 OSHA Workplace Permissible Noise Exposures

Duration per Day (hours)	Sound level (dBA)
8	90
6	92
4	95
3	97
2	100

Table 3.15-1 OSHA Workplace Permissible Noise Exposures

Duration per Day (hours)	Sound level (dBA)
1.5	102
1	105
0.5	110
Less than 0.25	115

dBA = decibels on the A-weighted scale.

Source: OSHA 1974.

Regulation 30 CFR Part 816.67, overseen by the Office of Surface Mining Reclamation and Enforcement (OSMRE), regulates the control of effects resulting from blasting activity in terms of noise and vibration resources.

3.15.1.3 Hazardous Materials

Hazardous substances are defined in various ways under a number of regulatory programs and can represent potential risks to both human health and the environment when not managed properly. The term “hazardous substances” includes the following materials that may be utilized or disposed of in conjunction with the proposed project:

- Substances covered under the OSHA Communication Standard aligned with the Globally Harmonized System of Classification and Labeling of Chemicals (29 CFR Part 1910.1200) and Mine Safety Health Administration Communication Standards (30 CFR Part 47). The types of materials that may be used in project-related activities and that would be subject to these regulations would include almost all of the materials covered by the regulations identified below.
- Hazardous materials as defined under the USDOT regulations (29 CFR, Parts 170-177). The types of materials that may be used in project-related activities and that would be subject to these regulations would include fuels, paints and coatings, and other chemical products.
- Hazardous substances as defined by the Comprehensive Environmental Response, Compensation, and Liability Act and listed in 40 CFR Part 302.4. The types of materials that may contain hazardous substances that may be used in project-related activities and that would be subject to these requirements include certain solvents, solvent-containing materials (e.g., paints, coatings, degreasers), acids, and other chemical products.
- Hazardous waste as defined in the Resource Conservation and Recovery Act (RCRA) - procedures in 40 CFR Parts 260, 261, and 262 are used to determine whether a waste is hazardous. The types of materials used in project-related activities and that would be subject to these requirements could include flammable liquid with a flash point less than 140 degrees Fahrenheit, spent solvent, and corrosive liquids.
- Any “hazardous substances” and “extremely hazardous substances” as well as petroleum products (e.g., gasoline, diesel, or propane) are subject to reporting requirements if volumes on-hand exceed threshold planning quantities under Sections 311 and 312 of the Superfund Amendments and Reauthorization Act. The types of materials that may be used in project-related activities and that would be subject to these requirements include fuels, coolants, acids, solvent-containing products such as paints and coatings, and any hazardous materials and chemicals that fall under the OSHA and Mine Safety Health Administration hazard communication standards as well as 29 CFR Part 1910 and 1926 Subpart Z Table Z-1.

- Petroleum products defined as "oil" in the Oil Pollution Act of 1990. The types of materials used in project-related activities and that would be subject to these requirements include fuels, lubricants, hydraulic oil, and transmission fluids.

In conjunction with the definitions noted above, the following lists provide information regarding management requirements during transportation, storage, and use of particular hazardous chemicals, substances, or materials:

- Superfund Amendment and Reauthorization Act Title III List of Lists or the Consolidated List of Chemicals Subject to the Emergency Planning and Community Right-to-Know Act and Section 112(r) of the Clean Air Act.
- USDOT listing of hazardous materials in 49 CFR Part 172.101.
- Pursuant to regulations promulgated under the Comprehensive Environmental Response, Compensation, and Liability Act, as amended by the Superfund Amendment and Reauthorization Act, release of a reportable quantity of a hazardous substance to the environment must be reported within 24 hours to the National Response Center (40 CFR Part 302).

3.15.1.4 Solid Waste

Solid waste includes a broad range of materials including garbage, refuse, wastewater treatment plant sludge, non-hazardous industrial waste, and other materials (e.g., solid, liquid, or contained gaseous substances) resulting from industrial, commercial, mining, agricultural, and community activities (U.S. Department of the Interior-OSMRE 2011). Solid waste is regulated under different subtitles of the RCRA and includes non-hazardous waste and hazardous waste. Non-hazardous waste is regulated under RCRA Subtitle D.

A solid waste generated by coal-fired power plants is coal ash, often referred to as coal combustion residuals (CCRs). In December 2014, the USEPA issued new regulations for the disposal and handling of CCRs. The USEPA's regulatory determination was that CCRs would be regulated under Subtitle D of the Resource Recovery and Conservation Act (USEPA 2014).

Universal waste is a category of waste materials designated as 'hazardous waste,' but containing materials that are common. It includes batteries, pesticides, mercury containing equipment, and lamps containing mercury as defined in 40 CFR Part 273.

While potentially hazardous if made friable, the handling and disposal of asbestos is not regulated under the RCRA. Rather it is regulated under the National Emission Standards for Hazardous Air Pollutants program.

3.15.2 Study Areas

3.15.2.1 Proposed Action and Action Alternatives

The public safety study area for the NGS is the NGS with a 3-mile buffer. The study area for the Kayenta Mine is the proposed KMC permit area with a 3-mile buffer, inclusive of noise-sensitive receptors such as residences within the proposed KMC permit area. The NGS and proposed KMC are displayed on **Figure 3.14-1**. A 3-mile buffer was applied to the NGS and its associated facilities and KMC to account for noise-related impacts, and was selected based on attenuation of a 100-dBA noise source to approximately 50 dBA, a sound level that generally is considered to be quiet. The public safety study area for the Black Mesa & Lake Powell (BM&LP) Railroad is 200 feet either side of the BM&LP Railroad. The 230-kilovolt (kV) and 500-kV transmission lines also have a study area of 200 feet of either side of the transmission lines.

The study area for hazardous materials and solid waste includes the NGS site, proposed KMC permit area, and the major transportation routes used to deliver bulk products and chemicals to both facilities. The hazardous materials and solid waste study area also includes the BM&LP Railroad right-of-way (ROW) that extends from the proposed KMC to the NGS.

3.15.2.2 Cumulative

The cumulative impacts study areas for public safety and noise, hazardous materials, and solid waste are the same as for the Proposed Action and action alternatives.

3.15.3 Affected Environment

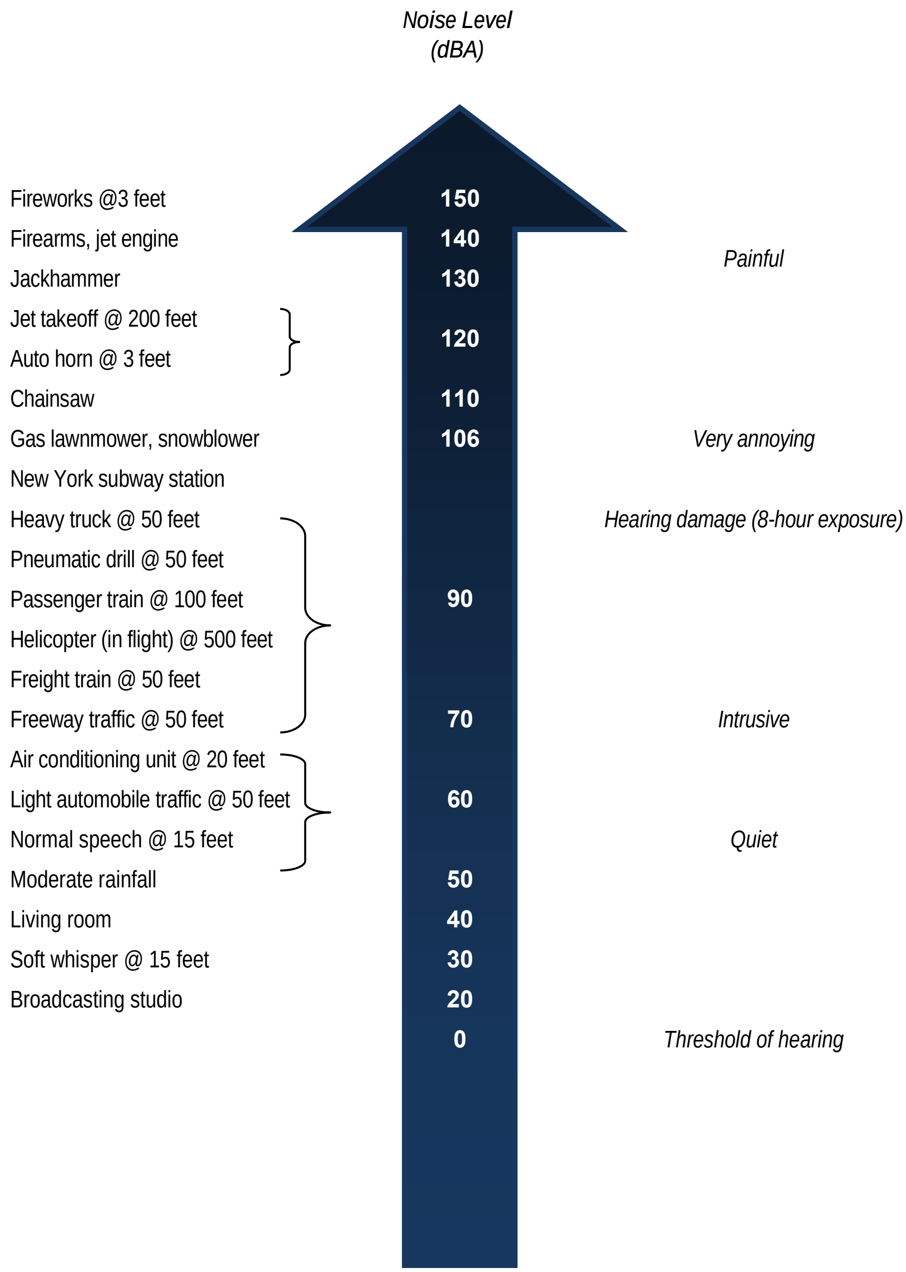
The affected environment for public safety and noise include human resources that could be affected by noise and vibrations. The historical noise and vibration environment near the Kayenta Mine and NGS has been dominated by noise associated with mining and power plant operations, including coal processing, blasting, and rail hauling and unloading. Low frequency vibrations include those from heavy equipment or trucks traveling through the study area and blasting. Sensitive receptors to noise and vibration include residences, with approximately 19 residences located inside or within close proximity to the proposed KMC permit boundary. No other human sensitive receptor sub-populations (e.g., school, hospital, long-term care facility) were identified in or around the proposed KMC area. There are six noise sensitive receptors (i.e., residences) within the NGS study area; four are located approximately 1 to 2 miles to the southeast of the NGS facility near Arizona Highway 89, and two, a residence and the Navajo Nation Park Entrance, are located 0.5 mile south and 0.75 mile west, respectively, of the NGS pump station at Lake Powell.

Sound level measurements are often adjusted or weighted, and the resulting value is called an “A weighted” sound level. The dBA measurements are standardized at a reference value of zero decibels (0 dBA), which corresponds to the average threshold of human hearing (OSHA 2015a). The A-rated scale is logarithmic, that is, a sound that is 10 decibels louder is perceived by the human ear as twice as loud (Hanson et al. 2006). As a result, methods have been developed for weighting the sound frequency spectrum to approximate the response of the human ear. The dBA scale is widely used for environmental noise assessments because of its relative convenience and accuracy in correlating with people’s judgments of what constitutes noise. Typical A-weighted sound and noise levels associated with common activities or situations are shown on **Figure 3.15-1**.

Vibration occurs when energy is released from some type of activity such as blasting or heavy truck movement, and is converted into vibrations as either ground motion or air overpressure (air blast). Ground motion is a wave motion that spreads outwards from the blast, and is the principal vibration that could result from blasting. This ground motion is measured as peak particle velocity and is used as an indicator of possible blast damage (OSMRE 2011). Air blast may be more noticeable because of the accompanying noise effects. Like other noises, air blast is measured in decibels; however, the overpressure normally is at low frequencies, so an air blast may be felt more than heard. Blasting activity only occurs at Kayenta Mine.

The affected environment for hazardous materials and solid waste includes air, water, soil, and biological resources within the study area that could be affected by an accidental release of products, chemicals, hazardous materials, or solid wastes during transportation to or from the NGS and proposed KMC, transportation along the railway ROW, or during on-site storage, disposal, or use.

The volumes of hazardous materials used, and the generation of solid waste during maintenance of the transmission lines, substations, switchyards, and communication sites, are considerably less than used or generated at the NGS and Kayenta Mine. In addition, the use and disposal of these materials are episodic and depend on the required maintenance or repairs.



Source: Council on Environmental Quality 1970.

Figure 3.15-1 Typical A-weight Sound Levels

3.15.3.1 Navajo Generating Station

3.15.3.1.1 Public Safety and Noise

The main urban center closest to the NGS is the Town of Page (population 7,247 as of 2010), Arizona, which is located approximately 5 road miles to the west of the NGS power plant. There are six noise sensitive receptors (i.e., residences) within the NGS study area; four are located approximately 1 to 2 miles to the southeast of the NGS facility near Arizona Highway 98, and two are located 0.5 mile south of the NGS pump station at Lake Powell and 0.75 mile west of the NGS pump station at Lake Powell. The NGS Emergency Response Plan provides guidelines to augment the health and safety of NGS employees and the public in the event of an emergency, such as fire, explosion, hazardous materials release, terrorism, workplace violence, or other catastrophic event. The NGS Emergency Response Plan also pertains to the BM&LP Railroad. The Emergency Response Plan was developed in accordance with OSHA regulations and has been provided to local fire and hazardous materials teams. It also applies to enhancing the health and safety of the surrounding community in the event of an emergency. Formalized mutual aid agreements would further lessen the risk of impacts to the workers and the surrounding communities in the case of an emergency. Unwritten mutual aid agreements are in place with the City of Page, Peabody Western Coal Company (PWCC), National Park Service, Coconino County Sheriff’s Department, and Navajo Nation Police. Potential impacts to worker safety also would be reduced by the emergency action plan which has been developed in accordance with OSHA. The plan facilitates and organizes employee actions during workplace emergencies (**Appendix 1B**). The emergency action plan includes, but is not limited to means of reporting fires, evacuation procedures, procedures to account for all employees after an evacuation, and employee rescue and medical duties. Additional resources for an incident such as firefighting include 1 million gallons of water in the NGS Makeup Reservoir reserved for fighting fires.

Current noise and vibration at the NGS and associated facilities result from an assortment of sounds at varying frequencies from typical plant operations, as well as noise associated with coal rail operations and maintenance actions on associated facilities. Noise levels at the NGS are assumed to be similar to those experienced near the Kayenta Mine (detailed below), with the exception of Kayenta Mine blasting noise levels, as there are no blasting activities at the NGS.

The BM&LP Railroad is used to deliver coal from the Kayenta Mine to NGS. Ongoing operation, repair, preventative maintenance, and improvements of the railroad track structure, catenary system, crossing locations, crossing gates, signals, signage, ROW roads, water drainage systems, culverts, fire walls, and cattle guards are performed to ensure the safety of train operations and the public, and to prevent livestock from accessing the ROW. As part of the service program, each train receives a periodic exterior inspection. When maintenance activities are performed, emphasis is placed on the braking system and the integrity of the cars.

Safety is further enhanced by training railway operations teams to use standardized visual and auditory signals for public safety communication. The locomotive horn, bells, and flashing ditch lights are used at crossings. Headlights are used to increase train visibility when a train is in motion and flares are used at night to warn motorists when a crossing is blocked by a stationary train.

Train operation is limited to a maximum of 50 miles per hour. Trains also are required during vision-impairing weather conditions to slow down to a speed that ensures safety and to stop when tracks are flooded. Bells and whistles must be sounded frequently under these conditions. Troubleshooting and repair personnel are dispatched to restore function as soon as possible when a concern is identified. To protect operators and the public when railroad crossing signals and gates are taken out of service for repair, a “stop and proceed” order is given to train operator crews, and the crossings are flagged by NGS personnel until the crossing can be returned to normal service. The railroad ROW corridor is fenced, except at the open grade crossings, to keep livestock away from the rail line. When notified that a ROW fence has been removed or damaged, a crew is dispatched to repair the fence to prevent livestock from entering the ROW. Should livestock be injured by train operations, livestock owners with a grazing permit along the ROW may file claims for losses through Salt River Project Agricultural Improvement and Power District's (SRP's) Litigation and Claims Department.

Public safety warning devices at 36 low-use public crossings include railroad crossing (cross buck) warning signs and stop signs. The crossings at Mileposts 31, 42, 55, and 66 have automated electronic warning lights and bells as additional safety warnings to the public. Crossing arms are installed at Milepost 66 where Arizona Highway 98 crosses the rail line. Although there have been approximately 10 to 15 incidents involving the train and motor vehicles, including three incidents in the past 15 years, the BM&LP Railroad has never been deemed responsible for any railroad crossing incident involving a motor vehicle (**Appendix 1B**).

After coal is delivered via rail, it is processed by the NGS coal handling system. Dust emissions in the coal handling system are controlled by two dust-suppression systems – train unloading dust suppression and coal conveyor dust suppression. For train unloading, a dust suppression misting system is used when dumping coal from the rail cars into the track hopper. Conveyors, except the yard conveyor, are housed in enclosed conveyor galleries. Dust extractors and openings supply adequate ventilation in conveyor galleries for personnel ventilation, which also reduces the risk of coal dust explosions.

Noise connected with the BM&LP Railroad is related to coal loading from the silos at the rail loading site north of U.S. Highway 160 (**Figure 1-9**) and unloading activity at the NGS, the locomotive horn, and bells that are used at crossings. The nearest sensitive receptors to the BM&LP Railroad coal-loading silos are a cluster of homes located 800 feet from the railroad on the south side of U.S. Highway 160.

3.15.3.1.2 Hazardous Materials Transportation, Storage, and Usage

Storage tanks installed at the NGS, ranging from over 55 gallons to more than 5 million gallons, are used to store a variety of liquid hazardous materials used in plant operations. These materials include diesel, gasoline, turbine lube oil, transformer oil, antifreeze, and used oil. Chemicals also are stored in tanks and include sulfuric acid, sodium hydroxide, ammonium hydroxide, ferric sulfate sodium hypochlorite, scale inhibitor, and other corrosive chemicals. A list of storage tanks used to store hazardous materials is included in the Operations and Maintenance Plan (**Appendix 1B**). The hazardous material used in the largest quantity is diesel fuel. Depending on the overhaul status of the boiler, annual diesel fuel consumption can range from 1.1 to 1.8 million gallons. Current vehicle fuel usage at the NGS site is limited to unleaded gasoline and diesel fuel, and current gasoline and fuel use is approximately 255,000 gallons per year. A summary of vehicle fuel use is provided in the Operations and Maintenance Plan (**Appendix 1B**).

There are multiple oil-filled transformers, including three for each unit's generator. The oil provides electrical insulation and cooling.

Transportation of chemicals to the NGS is outlined below. All chemicals are transported on highways and NGS facility access roads. **Table 3.15-2** provides information on bulk chemical and product transportation.

Table 3.15-2 Major Bulk Chemical and Product Deliveries to NGS

Product	Truck Deliveries per Year	Load Size	Point of Origin
Limestone	3,664	25, 37.2, or 41 tons	Apex, Nevada
Calcium bromide for mercury control[1]	300-500	3,200 gallons	To be determined
Powder activated carbon for mercury control[1]	To be determined	To be determined	To be determined
Diesel[2]	175	7,200 gallons	Holbrook, Arizona; Phoenix, Arizona; Las Vegas, Nevada; Farmington, New Mexico American Forks, Utah
Ammonium hydroxide[2]	3	45,000 pounds	Salt Lake City, Utah
Caustic soda[2]	5	3,600 gallons	Buckeye, Arizona
Sulfuric acid[2]	151	3,300 gallons	Haden, Arizona
Lime[2]	122	40 tons	Cricket Mountain, Utah
Ferric sulfate[2]	30	135,000 pounds	Salt Lake City, Utah
Sodium hypochlorite[2]	30	45,000 pounds	Henderson, Nevada
Hydrogen[2]	11	111,000 cubic feet	Phoenix, Arizona
Carbon dioxide[2]	10	9.3 tons	Phoenix, Arizona
Nitrogen[2]	2	53,000 cubic feet	Tucson, Arizona
Soda ash[2]	263	24 tons	Argus, California

1 Based on projected actuals.

2 Based on 2014 actuals.

Source: Operations and Maintenance Plan (**Appendix 1B**).

3.15.3.1.3 Solid Waste Disposal

Solid wastes (non-hazardous and hazardous) are disposed of in on-site and off-site facilities. **Table 3.15-3** lists the wastes that are disposed off-site. Among the waste that is disposed off-site is RCRA hazardous waste. NGS currently operates as a Small Quantity Generator and implements a Hazardous Waste Minimization Plan using the best available and affordable waste management methods to minimize waste generation. Hazardous waste minimization includes training on strategies for eliminating and minimizing waste at the source, recycling, reclaiming, and reusing material. Annual hazardous waste generation at NGS was reduced to 1,274 pounds in 2014 compared to 39,000 pounds in 1991 (**Appendix 1B**).

Table 3.15-3 Annual Off-site Solid Waste Volume and Disposition

Waste Stream	Average Annual Amount over a 5-year Period (2010-2014)	Annual Amount Generated (2014)	Ultimate Disposition/Site	Transportation
Bulk solid waste (non-RCRA and does not include CCRs)	Not Available	3,848 cubic yards	Washington County Landfill, UT	Republic services
Used oil rags	23.1 tons	19.2 tons	Subtitle D Landfill/Waste Management – Butterfield Landfill, AZ	MP Environmental Services, Inc.
Arsenic-treated cooling tower wood (exempted wastes)	1.53 tons	0 tons	Subtitle D Landfill/Waste Management – Butterfield Landfill, AZ	MP Environmental Services, Inc.
Hazardous waste (e.g., lab wastes, mixed solvents, and oil-based paint)	3,165 pounds	1,274 pounds	Clean Harbors – Aragonite, UT (incineration) and Grassy Mountain, UT (Subtitle C landfill); Veolia, Port Arthur, TX (incineration); US Ecology, Beatty, NV (Subtitle C landfill)	MP Environmental Services, Inc.
Used Oil	11,677 gallons	17,120 gallons	Recycled with Thermofluids	Thermofluid
Universal Waste (e.g., lamps, batteries, and mercury-containing equipment)	820 pounds of lamps/153 pounds of batteries/957 pounds of mercury-containing equipment	1,385 pounds of lamps/114 pounds of batteries; 142 pounds of mercury-containing equipment	Recycled with Veolia, Phoenix, AZ	Veolia Phoenix
Polychlorinated Biphenyl Electrical Equipment	1,057 kilograms	920 kilograms	Clean Harbors – Aragonite, UT (incineration) and Grassy Mountain, UT (Subtitle C landfill); Veolia, Port Arthur, TX (incineration); US Ecology, Beatty, NV (Subtitle C landfill)	MP Environmental Services, Inc.

Source: Operation and Maintenance Plan (**Appendix 1B**).

3.15.3.1.4 On-site Material Management

The on-site asbestos landfill is used only to dispose of asbestos-containing material generated during abatement or demolition activities (**Appendix 1B**). The landfill does not accept waste generated outside of the plant site. The 3-acre landfill is southeast of the railroad loop and has a fenced perimeter with a gated entrance. Currently less than half of the site has been used for disposal of asbestos-containing materials. In 2014, the NGS disposed of about 24 cubic feet of asbestos containing materials (**Appendix 1B**). The average annual amount of asbestos-containing material disposed from 2008 to 2014 was 124 cubic feet.

Non-hazardous solid waste was formerly disposed at the NGS Solid Waste Landfill. As of 2016, the solid waste landfill is inactive, and all non-hazardous waste is transported to an off-site landfill. Historically, the on-site landfill received mostly industrial waste, construction materials, and miscellaneous demolition debris. In 2015, a new policy was implemented with the expectation that nearly all of the non-hazardous solid waste would be transported and disposed by off-site vendors (**Appendix 1B**).

CCRs are disposed of at the ash disposal site pursuant to the CCR regulations (see above and **Appendix 1B**). The CCRs generated at the plant include fly ash, economizer ash, bottom ash, and flue-gas desulfurization gypsum by-product (**Appendix 1B**). Fly ash is recycled in large amounts ranging from 350,000 to 500,000 tons (50 to 90 percent of the annual fly ash output). The fly ash is sold as a by-product and is used in a variety of applications where it can be bound into materials including wallboard, concrete, roofing materials, and bricks (USEPA 2015a). The largest use of fly ash is in concrete, concrete products, and grout. The materials that are not recycled are placed into the ash disposal site. **Table 3.15-4** lists the types and amounts of CCRs that were disposed of in 2014. At the ash disposal site, the CCR is placed in lifts directly on bedrock or compacted dunes. The lifts are 2 to 3 feet thick and are grouped into embankments that do not exceed 15 feet in thickness. The final lift is covered with 2 feet of native soil and the embankments are terraced to reduce or divert runoff.

Table 3.15-4 CCR Disposal in 2014

CCR Type	Tons
Disposal at On-site Ash Disposal Site	
Bottom and economizer ash	173,394
Fly ash	295,246
Scrubber by-products	458,048
Sold to Off-site Vendor	
Fly Ash	380,739

Source: Operation and Maintenance Plan (**Appendix 1B**).

3.15.3.2 Proposed Kayenta Mine Complex

3.15.3.2.1 Public Safety and Noise

The main hazards associated with mining and explosives use are the handling of explosives by workers and the proximity to the blast site. Blasting is used during mining operations to fragment material for excavation and transport. Blasting operations at the Kayenta Mine are conducted according to federal law, applicable regulations, and the approved permit application. Also, under OSMRE's permitting requirements, a resident or owner of a dwelling or structure within 0.5-mile of any part of the permit area may request that a pre-blasting survey be conducted on their dwelling or structure. Upon receipt of this request, PWCC conducts the survey by analyzing the conditions of the dwelling or structure prior to blasting activities and documenting any pre-blasting damage and other physical factors that could be affected by the blasting (OSMRE 2011). A written report is prepared and a signed copy provided to the regulatory authority and the person requesting the survey (OSMRE 2011, 1983).

Blasting at the Kayenta Mine occurs about twice daily during weekdays between sunrise and sunset at a distance no closer than 0.5 mile from an occupied dwelling. There are three residences within or adjacent to current or future mining areas. One residence is adjacent to mining area N-10 and two residences are within area N-11E. Residents in or near the blasting area are evacuated prior to proceeding with any blasting operations. Warnings and all-clear signals audible for 0.5 mile are sounded before and after blasting. Except for emergencies, blasting occurs according to a schedule that is published annually in a newspaper with general circulation in the mining area. Blasting schedules also are delivered to all individuals living within the Kayenta Mine permit area and within 0.5 mile outside the permit area (OSMRE 2011).

Blasts are monitored for air blast and ground vibration twice per year in June and December. PWCC monitors airblast and ground vibration for all shots exceeding the scaled distance equation, as well as any required by the regulatory authority at their requested location(s). The OSMRE reviews the Kayenta Mine's blasting records monthly during field inspections (OSMRE 2011; PWCC 2012 et seq.). More information regarding blast warning signs, signals, surveys, and monitoring is detailed in **Appendix 1D**.

The Mine Safety and Health Administration regulates the storage of explosives used for blasting activities (30 CFR Parts 56 and 57). Mine Safety and Health Administration requires that explosives be secured in magazines or other appropriate explosive materials storage facilities. These facilities must be bullet-resistant, theft-resistant, fire-resistant, weather-resistant, and ventilated for the storage of explosives and detonators. Furthermore, areas surrounding storage facilities for explosive material should be clear of rubbish, brush, dry grass, and tress for 25 feet in all directions, with the exception that live trees 10 feet or taller are not required to be removed. Also, other combustibles are not to be stored or allowed to accumulate within 50 feet of explosive material.

Ambient noise conditions encountered in the study area consist of a variety of sounds at varying frequencies (Hanson et al. 2006). Existing mining-related noise within the proposed KMC is associated with operations, including blasting, coal hauling, and coal processing (OSMRE 2011).

The loudest single mining and excavation equipment noise source is the rock drill, which produces noise of 98 dBA at 50 feet (Hanson et al. 2006). Sensitive noise receptors in the proposed KMC are residences near the intersection of U.S. Highway 160 and Navajo Route 41 and along Moenkopi and Dinnebito washes. Noise levels expected at sensitive receptor locations within and adjacent to the proposed KMC were estimated from typical mining equipment noise levels and are listed in **Table 3.15-5**.

Table 3.15-5 Noise Levels at Various Distances from Typical Mining Equipment

Construction Equipment	Noise Level[1] at Distances (dBA)					
	50 feet	100 feet	200 feet	400 feet	800 feet	1,600 feet
Bulldozer	85	79	73	67	61	55
Concrete Mixer	85	79	73	67	61	55
Concrete Pump	82	76	70	64	58	52
Crane, Derrick	88	82	76	70	64	58
Crane, Mobile	83	77	71	65	59	53
Front-end Loader	85	79	73	67	61	55
Generator	81	75	69	63	57	51
Grader	85	79	73	67	61	55

Table 3.15-5 Noise Levels at Various Distances from Typical Mining Equipment

Construction Equipment	Noise Level[1] at Distances (dBA)					
	50 feet	100 feet	200 feet	400 feet	800 feet	1,600 feet
Rock Drill	98	92	86	80	74	68
Shovel	82	76	70	64	58	52
Truck	88	82	76	70	64	58

[1] The equivalent steady-state sound level that contains the same varying sound level during a 1-hour period.

Source: Hanson et al. 2006.

Based on the noise sources identified in **Table 3.15-5**, existing sound levels at 50 feet from equipment are likely to range from 80 to 95 dBA for typical daytime noise levels, depending on the level of intensity of mining activities and distance from the noise source. For comparison, 40 dBA is relatively quiet and can be equated to the noise level of a residence at night, while 60 dBA is comparable to a normal conversation and is considered a comfortable noise level (**Figure 3.15-1**). Noise from a point source, such as construction or mining equipment, decreases approximately 6 dBA per doubling of the distance to a sensitive noise receptor (OSMRE 2011; Traux 1999). For example, a source that emits 85 dBA at 50 feet decreases to 79 dBA at 100 feet (OSHA 1999). This concept is known as geometric spreading which results in the energy twice as far from the source being spread over four times the area, hence the sharp drop off in intensity. Sound intensity is subject to geometric spreading assuming there are no reflections or reverberations.

Low frequency vibrations normally are felt rather than heard. Existing sources of vibrations within the study area may include heavy equipment, trucks, or blasting. Monitored levels for ground movement and overpressure from the mining operation have not exceeded established OSMRE limits (OSMRE 2011; PWCC 2012 et seq.).

Flyrock is rock that is ejected into the air or along the ground from a blast. Flyrock is controlled by the blasting design. Additionally, access near the blast site is restricted. The federal regulation in 30 CFR Part 816.67 (c) prohibits flyrock from being cast more than one-half the distance to the nearest dwelling, beyond the area of control (required under 30 CFR Part 816.66 (c)), or beyond the permit boundary (OSMRE 2011).

Along Navajo Route 41, PWCC assists with maintenance of the road surface and slopes and coordinates maintenance with the Navajo Nation Department of Transportation for repaving and seal coating the road, or through their own roadway maintenance contract to maintain roadway shoulders and drainage. Some residents state that Navajo Route 41, from the former Black Mesa Mine facilities to the southern lease area boundary, and the Kayenta Mine road should both be paved for safety and dust control reasons. Residents also would like to see the paved portion of Navajo Route 41 realigned and improved to higher standards. To ensure public safety along the mine roads, public traffic is excluded from the active mine area by security gates. Security gates decrease the potential for heavy mining vehicles to interact with vehicles driven by the public. All roads are signed and maintained by grading and dust suppression, and school buses and deliveries are escorted by PWCC security vehicles (OSMRE 2011). PWCC also conducts snow removal and application of gravel and salt when needed.

3.15.3.2.2 Hazardous Materials, Chemicals, Products, and Solid Waste

Potential hazardous waste that is recycled includes batteries, computer equipment, fluorescent lamps (4-foot and 8-foot lengths), high-pressure sodium light bulbs, and mercury-vapor light bulbs (OSMRE 2011). Non-hazardous materials that are recycled consist of scrap metal and tires. Other waste that requires analysis before disposal or recycling includes used oil, parts washer fluid, spent solvent, grease, and antifreeze. The Kayenta Mine is classified as a small quantity generator of hazardous waste

(USEPA 2016). Small quantity generators generate more than 100 kilograms, but less than 1,000 kilograms, of hazardous waste per month. These materials are either recycled or disposed in accordance with the results of testing to determine appropriate off-site disposal.

The primary products and chemicals transported to, and stored and used at, the Kayenta Mine are listed in **Table 3.15-6**. All chemicals and products used are transported on major highways and Kayenta Mine facility access roads. Under the regulatory framework described above, diesel fuel is the largest by volume of the products used at the Kayenta Mine.

Table 3.15-6 Major Bulk Chemical and Product Deliveries to Kayenta Mine

Material	Estimated Annual Use	Unit
Diesel	5,400,000	Gallons
Gasoline	145,000	Gallons
Lubricating oil	100,000	Gallons
Gear Oil	11,300	Gallons
Hydraulic Oil	1,000	Gallons
Vehicle antifreeze	16,000	Gallons
Ammonium Nitrate	25,000,000	Pounds

Source: Lehn 2015.

The major waste streams at the Kayenta Mine include non-hazardous waste, materials that could be considered hazardous but are recycled, and hazardous waste (OSMRE 2011). Non-hazardous waste is collected and transported by a contractor and disposed off-site in a permitted landfill. Previously, such waste was disposed on-site at the "J-3 Landfill" which was closed after submittal of a reclamation plan in 1998 (PWCC 2012 et seq.). A bioremediation treatment unit for petroleum contaminated soil was operated until 2014 when closure was approved by the Navajo Environmental Protection Agency.

3.15.3.3 Transmission Systems and Communication Sites

3.15.3.3.1 Public Safety and Noise

There are three 500-kV transmission lines and one 230-kV transmission line associated with the NGS power transmission. Nineteen communication sites occur in the project area and most are co-located with other facilities. There are no sensitive receptors under or within 200 feet of either side of the 230-kV or 500-kV transmission lines.

Public health and safety concerns associated with transmission lines typically are focused on the effects of electromagnetic fields. The electric field created by high voltage transmission lines extends from the energized conductor to the other conducting objects. Resulting field effects include induced current and voltage in the ground, structures, vegetation, buildings, vehicles, and people near the transmission line. The electric field or voltage gradient is expressed in units of volts per meter or kVs per meter. There are no federal standards for transmission line electric fields. Typical average electric field readings for a 230-kV line and a 500-kV line at the edge of the study area (200 feet from ROW centerline) are depicted in **Table 3.15-7**.

Table 3.15-7 Noise and Average Electric and Magnetic Field Strengths at Study Area Edge

Transmission Line Capacity	Average Magnetic Field at Study Area Edge	Average Electric Field at Study Area Edge	Noise Levels at Study Area Edge
230-kV	9 milliGauss	0.1 kV per meter	20 dBA
500-kV	20 milliGauss	0.6 kV per meter	48 dBA

Source: Bureau of Land Management (BLM) 2011.

Magnetic field strength is expressed in terms of teslas or gauss. While electric fields can be easily shielded or reduced by walls and other objects, magnetic fields cannot, and they are more likely to penetrate into the body. The International Commission on Non-Ionizing Radiation Protection in a November 2010 release stated that the exposure limits for magnetic fields was 2,000 milliGauss for the public (International Commission on Non-Ionizing Radiation Protection 2010). Typical homes produce background magnetic levels (away from appliances and wiring) that range from 0.5 milliGauss to 4 milliGauss, with an average value of 0.9 milliGauss (USEPA 1992). Natural static magnetic fields from the earth are near 0.6 milliGauss. There are no federal standards for transmission line electric fields; however, the International Commission on Non-Ionizing Radiation Protection has set a voluntary protection level for electrical fields for the general public of 4.2-kV per meter (International Commission on Non-Ionizing Radiation Protection 1998). Typical average magnetic and electric field readings for a 230-kV line and a 500-kV line at the edge of the study area (200 feet from ROW centerline) are depicted in **Table 3.15-7** (BLM 2011).

Corona is the electrical breakdown of air into charged particles caused by the electrical field at the surface of conductors, insulators, and hardware of energized high-voltage transmission lines. Corona-generated audible noise generally is characterized as a crackling/hissing noise, most noticeable during wet-weather conditions. Noise level from a line source such as a power line will decrease by 3 dBA for every doubling of the distance away from the source (Truax 1999). This concept is known as cylindrical spreading. Noise levels at the edge of the 230-kV and 500-kV study area are depicted in **Table 3.15-7** (BLM 2011).

Fire along electric transmission lines, specifically in forested areas, is another source of public safety concern. During the 2010 to 2015 time frame, there were approximately 4,833 fires which occurred in Arizona on BLM and National Forest lands and burned on average 266 acres per fire (Geographic Area Coordination Center 2016). Appendix 3 (Industrial Fire Precaution Plan) of the Arizona Public Service Company Transmission Line Corridor Management Plan for 500-2, Prescott National Forest (**Appendix 1B**) details steps that contractors would take to reduce fire risk while conducting vegetation maintenance within the transmission line corridor. Vegetation maintenance within the transmission line corridor serves to provide protection against wildfires by reducing the potential for fire ignition from vegetation in and around the power lines. It also reduces fuel load under the lines, thereby reducing the potential for existing fires to damage structures or cause power fault in the lines. The Transmission Line Corridor Management Plan also details Best Management Practices to facilitate fire reduction. Additionally, where needed, Arizona Public Service Company maintains a 20-foot radius around steel footers free of shrubs, trees, or other such vegetation to provide a fire break to minimize arcing of electricity or burning of structures during a fire under or near the transmission line.

Maintenance activities around communication sites also are conducted to minimize fire risk. Typical maintenance activities to prevent fire at communication sites include clearing of vegetation within the site grounds and at the fence line.

3.15.3.3.2 Hazardous Materials and Solid Waste

Hazardous materials used in the operation and maintenance of the transmission line corridors and communication sites consist primarily of vehicle fuel, propane for emergency backup generators, and di-electric oil used in the electrical equipment at the substations. Solid waste generation consists of scrap metal, debris, and office and shop trash.

3.15.4 Environmental Consequences

3.15.4.1 Issues

3.15.4.1.1 Public Safety and Noise

The major issues concerning public safety and noise are listed below.

- Potential public safety impacts associated with the NGS and BM&LP Railroad operations.
- Potential injuries from blasting and construction and the storage of explosives at the proposed KMC.
- Potential exceedance of federal noise and blasting levels at sensitive receptors near the proposed KMC.
- Potential transmission line electromagnetic field exposure.
- Potential transmission line noise

3.15.4.1.2 Hazardous Materials, Chemicals, Products, and Solid Waste

The major concerns regarding hazardous materials and solid waste include issues listed below.

- Potential spills and releases of hazardous chemicals or substances that exceed regulatory thresholds.
- Improper handling and disposal of waste that would pose a threat to public health and the environment.

3.15.4.2 Assumptions and Impact Methodology

3.15.4.2.1 Public Safety and Noise

The methodology for evaluating impacts on public safety involves identifying and assessing design, construction, and operational standards and guidelines for the project components and determining potential effects on sensitive receptors within the study areas. Noise and vibration impacts are evaluated based on the extent the activity could exceed federal noise and vibration regulations at sensitive receptors.

3.15.4.2.2 Hazardous Materials and Solid Waste

The impact analysis involved the review of a variety of sources including information from the project proponents, government agencies, and published documents. The review of data sources documented potential impacts of hazardous materials and the generation and disposal of solid waste, including CCR, and hazardous waste. The assessment:

- Identifies potential impacts associated with CCR disposal;
- Analyzes the impact on soil and water resources from potential spills and releases; and
- Identifies applicable mitigation measures, if necessary.

Assumptions used in the assessment of risks involving hazardous materials and solid waste are listed below.

- The review of solid waste handling and disposal was not intended as a comprehensive audit of regulatory compliance, but rather to disclose potential impacts under the National Environmental Policy Act.
- The analysis was not concerned with nearby off-ROW or off-site contaminated sites not owned or operated by the proponents. The reason for this limitation is that the NGS, the BM&LP Railroad, the Western Transmission System (WTS), and Southern Transmission System (STS) are existing facilities and would not be expanded outside their previously established boundaries. The proposed KMC would operate through 2044, but it would not overlap with the activities of the former Black Mesa Mine except where existing Black Mesa Mine support facilities are currently being used by the Kayenta Mine, and would be used in the future.
- Use of hazardous materials and generation of solid waste at the facilities relied on information provided by the proponents.
- Accident and incident data were obtained from publically available data provided by federal and state governmental agencies.

3.15.4.3 Proposed Action

3.15.4.3.1 Navajo Generating Station

3.15.4.3.1.1 Public Safety and Noise

The impact analysis study area for the NGS is detailed in Section 3.15.2. To reduce public safety risks, health and safety procedures and the NGS Emergency Response Plan and Emergency Action Plan would be updated and modified, as needed. No noise impacts from NGS operation would occur outside the plant boundaries as there are no sensitive receptors within 200 feet of the BM&LP Railroad. The nearest sensitive receptors to the NGS are four scattered residences approximately 1 to 2 miles to the southeast near Arizona Highway 98, and a residence and the Navajo Nation Park Entrance located 0.5 mile south and 0.75 mile west, respectively, of the NGS pump station at Lake Powell. At these distances no noise impacts are anticipated at these sensitive receptors.

Under the Proposed Action, impacts to public safety from potential rail accidents due to future operation of the BM&LP Railroad would be lessened by ongoing and future maintenance and improvements. These improvements would include, but would not limited to, the replacement and improvement of the railroad ties along the entire line; replacement and improvement of power feeder lines, poles, transformers; and installation of new road crossings and related warning systems (**Appendix 1B**). In addition, the NGS Emergency Response Plan would apply to railway operations. Based on continued implementation of the maintenance and improvement activities and the plan, it is anticipated that impacts associated with ongoing operation of the BM&LP Railroad, such as vehicle or livestock collisions, would be minor.

Additionally, activity on the BM&LP Railroad would stay the same or be incrementally reduced as compared to historical BM&LP Railroad activity. The distance of sensitive receptors from the BM&LP railroad as well as the long-term historical presence of the BM&LP railroad would result in negligible impacts to sensitive receptors. Also, for the cluster of sensitive receptors approximately 800 feet from the railway on the south side of U.S. Highway 160, the highway would continue to contribute a substantial amount to the existing noise level in addition to the noise generated from BM&LP railroad operations.

Under the Proposed Action, the operating and support facilities at the plant site would be dismantled and demolished to ground level by the end of 2045. Noise and vibration impacts associated with decommissioning of the NGS and BM&LP Railroad would be limited to removal of the operating and support facilities, and the overhead power lines, rails, ballast, ties, and structures, respectively. Noise from demolition also would include blasting from chimney removal and truck traffic for salvage material disposal. The nearest noise sensitive receptors to the NGS are four scattered residences approximately 1 to 2 miles to the southeast near Arizona Highway 98, and a residence and the Navajo Nation Park Entrance located 0.5 mile south and 0.75 mile west, respectively, of the NGS pump station at Lake Powell. At these distances no noise impacts are anticipated at these sensitive receptors.

3.15.4.3.1.2 Hazardous Materials Transportation

Under the Proposed Action, it is possible that anhydrous ammonia may be used for the selective catalytic reduction process to reduce nitrogen oxide emissions (described in detail in **Appendix 1B**). If anhydrous ammonia is used, under the 3-Unit Operation the selective catalytic reduction process would require approximately 17, 500 tons of anhydrous ammonia per year (**Appendix 1B**). Under the 2-Unit Operation, the use of anhydrous ammonia would be approximately 10,700 tons per year. Although there would be a number of products and chemicals used on-site, the discussion below is concerned with the two materials that present elevated risk. One material that presents elevated risk is anhydrous ammonia (anhydrous meaning that it contains no water). It presents elevated risk because it is classified as an extremely hazardous substance. The other substance that presents elevated risk is diesel fuel because large quantities of diesel fuel would be routinely stored and used on an annual basis (1.26 million gallons). The discussion below provides a review of the hazardous properties of the materials and a transportation risk assessment.

<u>Anhydrous Ammonia</u>

Ammonia and ammonia-compounds largely are used for agricultural fertilizer (80 to 90 percent); however, they also are used in other manufacturing and industrial processes such as water purification, cleaning compounds, refrigerant, pulp and paper, metallurgy, rubber, food, textile, leather, pharmaceuticals, and explosives (Agency for Toxic Substances and Disease Registry 2004).

Anhydrous ammonia is a USDOT hazardous material Class 2.2 - non-flammable compressed gas (49 CFR Part 173.115). While ammonia is a gas, it is more efficiently transported and stored as a liquid in pressure vessels. It is considered an extremely hazardous substance under the Emergency Planning and Community Right-to-Know Act reporting rules under Superfund Amendments and Reauthorization Act Title III, and the threshold planning quantity is 500 pounds (USEPA 2015b). As an extremely hazardous substance, it has physical characteristics that have the potential to harm people and the environment.

A common route of ammonia exposure is inhalation. Ammonia is an irritant to the respiratory system, but it also can affect the eyes and skin (Agency for Toxic Substances and Disease Registry 2004). Ammonia combines with water, creating ammonium hydroxide, a base that causes chemical burns to affected areas. Also, contact with the ammonia in liquid form can cause cryogenic (cold) injuries. Exposure to anhydrous ammonia can cause symptoms that vary from minor throat, lung, and skin irritation to severe chemical burns and pulmonary edema (OSHA 2015b). The work place exposure limit set by OSHA is 50 parts per million on an 8-hour time weighted average. Acute exposures can be fatal with concentration threshold levels from 5,000 to 10,000 parts per million (Agency for Toxic Substances and Disease Registry 2004). Anhydrous ammonia is probably not a carcinogen, but it may have synergistic effects with other compounds coupled with chronic exposure.

An ammonia spill to soil would result in fairly rapid conversion to nitrogen and subsequent uptake by microbes and plants except in places that would be the most impacted (Agency for Toxic Substances and Disease Registry 2004). If released into an aquatic environment, ammonia is highly toxic to aquatic life because it is very soluble in water. Fish are very vulnerable since ammonia interferes with the functioning of gills. Aquatic plants and invertebrates have a higher tolerance but can still be affected (Oram 2014). Lethal concentrations for fish range from 0.2 to 2.0 milligrams per liter. However, ammonia is not persistent in the environment and is fairly rapidly broken down and diluted.

In a catastrophic release to the air, the severest hazards and effects are closest to the source. An example would be the rupture of an ammonia tank under transport. Since the ammonia is under pressure, a puncture or rupture of the tank would cause a rapid loss of pressure, and the liquid ammonia would evaporate rapidly, but not instantaneously (Nordin 2006). The evaporation would be somewhat constrained because as the liquid evaporates, cooling occurs. As the ammonia evaporates, a visible plume would form in the air and would stay fairly close to the ground because, although ammonia is lighter than air, it readily mixes with water vapor. Because the evaporation is not instantaneous, liquid that leaks from the tank would pool on the ground, cooling or freezing whatever it contacts. In the case of a large spill (greater than 55 gallons) from a tanker truck or trailer, the USDOT recommends that persons be excluded up to a distance of 400 feet and that protective action distances downwind vary from 0.3 to 1.6 miles depending on atmospheric conditions and diurnal cycle (day or night) (USDOT 2012). Although anhydrous ammonia is not considered very flammable, when dispersed in the air it may be readily ignited. If the contents of a ruptured tank are on fire, a larger exclusion area may be necessary, at least 1 mile (National Institute of Occupational Safety and Health 2015).

Data for hazardous material incidents in Arizona over the period of 2012 to 2013 indicate there were 44 incidents involving non-flammable compressed gas (USDOT Hazard Class 2.2) out of a total of 922 hazardous material incidents (Arizona Division of Emergency Management 2013). In Coconino County, there were 10 hazardous material incidents from 2010 to 2013, but the hazard classes were not identified. However, there were no incidents involving the transportation of anhydrous ammonia in Coconino County from 2009 to 2015 (Pipeline and Hazardous Material Safety Administration 2016).There were only four reported releases of anhydrous ammonia in Arizona in 2014 (Right-to-Know Network 2016).

Because of the number of truck trips it would take to supply the plant with anhydrous ammonia under the 3-Unit Operation and 2-Unit Operation, the most likely impacts would occur due to a transportation incident. Nationally during the period from 2009 to 2014, most of the transportation-related incidents for anhydrous ammonia occurred while the material was in transit compared to material transfer, and in-transit storage incidents (Pipeline and Hazardous Material Safety Administration 2015). The handling and storage of ammonia at the plant would be governed by a response plan that would be in effect for emergencies that may occur at the plant. However, a transportation incident would occur in a less controlled environment, and the transportation company would be responsible for response and cleanup of incidents that may occur during transportation.

For this analysis, the transportation routes were limited to highways from Flagstaff to the power plant, a distance of 130 miles. Although it is likely that anhydrous ammonia would be trucked from Phoenix to Flagstaff on Interstate-17 or from other locations along Interstate 40, the increase in traffic due to the NGS plant (1.5 to 2.4 trucks per day) would statistically be very small since Interstate-17 averaged approximately 79,000 vehicles per day in 2014 (Arizona Department of Transportation 2015). The most likely transportation route would be U.S. Highway-89, but transportation could occur over Navajo Route 20 (Copper Mine Road) which intersects U.S. Highway 89 at Gap Express, about 17.0 miles north of the intersection of U.S. Highway 89 and U.S. Highway 160.

Table 3.15-8 lists the potential of an anhydrous ammonia spill for two annual use projections, for the 3-Unit Operation and 2-Unit Operation. The calculated number of incidents indicates that the probability of an incident or spill is low, even with the increased number of loads. If selective catalytic reduction is installed on all three units by 2024, then the calculated number of incidents over a 20-year time span (2024 to 2044) would be 0.28. Because of the low incident rate, after 20 years of hauling the chemical there is a low probability of a release. Therefore, impacts due to a release would be negligible to minor.

Table 3.15-8 Potential Transportation Incidents During Transportation of Chemicals and Products

Material	Case	Annual Use	Shipment Quantity	Number of Shipments per Year	Distance (miles)[1]	Accident/ Incident Rate[2]	Calculated Number of Incidents
Anhydrous Ammonia[3]	20 Years 3-Unit Operation	17,500 (tons)	20 tons	875	2,275,000	1.4×10^{-7}	0.32
	20 Years 2-Unit Operation	10,700 (tons)	20 (tons)	535	1,391,000		0.19
Diesel Fuel	25 Years (2019 to 2044) 2-Unit Operation	831,600 (gallons)	7,200 (gallons)	116	377,000	7.0×10^{-7}	0.26
	25 Years (2019 to 2044) 3-Unit Operation	1,260,000 (gallons)	7,200 (gallons)	175	568,750		0.40

1 130 miles from Flagstaff to NGS.

2 Table 25, Battelle Memorial Institute (2001), accident and incident rate per million miles. Incidents include non-accident releases during transit.

3 Anhydrous ammonia is not currently used at the NGS.

Diesel Fuel and Other Petroleum Compounds

A product that is used in large quantities at the site is diesel fuel. Other petroleum products include gasoline and other grades of fuel oils (Agency for Toxic Substances and Disease Registry 1995). These materials are combustible but have varying effects and persistence in the environment. In the case of a spill due a transportation accident, diesel fuel could have impacts to air, water, and soil depending on the location of an incident. Volatile compounds may be released into the air and, if ignition occurs, the uncontrolled burning could lead to the formation of combustion compounds and hydrocarbon particulates. If a spill were to go into a stream, the material, being lighter than water and not very soluble, would have a tendency to float on the surface and be carried downstream or to banks and affect plants and animals within and near the aquatic environment. Over a period of time, the oil may adhere to fine-grained particles and end up entrained in the stream sediments. In contact with soils, fuels rapidly degrade through the action of biodegradation (Agency for Toxic Substances and Disease Registry 1995).

For the substances described above, a large release (greater than 55 gallons [USDOT 2012]) could have implications for public safety, but the location of a spill would be the primary factor in determining the effects of a release. The probability of a release anywhere along the anticipated transportation route to the NGS is expected to be low. Because of the low population density along the route, the probability of a release within a populated area would be small. The only major streams that are crossed by the transportation route are considered intermittent or perennial. The Little Colorado River is classified as intermittent, and Moenkopi Wash is classified as intermittent or perennial (Arizona Department of Water Resources 2009). Given the lack of surface water receptors, there also is a low probability of impacts to surface water. The risk of impacts to groundwater also would be small because generally groundwater is too deep to be affected. The groundwater along the route ranges from 1,962 feet to 80 feet except in the vicinity of the Little Colorado River, where groundwater levels may be less than 50 feet below ground surface (Arizona Department of Water Resources 2009).

For either substance discussed above, the immediate effects of a transportation incident or accident could be severe, especially if cargo or fuel tanks are ruptured and a major spill occurs. However, the probability of an accident or in-transit release is low and the effects would be short-term. Based on the low probability of a transportation accident or release, and the procedures in place for use in the event of a release, the impacts would be minor depending on the location along the transportation route.

3.15.4.3.1.3 Hazardous Materials Storage and Use

Oils and fuels that are stored and used on-site are covered by a site-specific Spill Prevention, Control, and Countermeasure (SPCC) Plan. The SPCC Plan provides procedures to deal with spills or releases of oils, including petroleum and mineral oil. A SPCC program includes written prevention and spill response plans, notification in case of a spill, periodic inspections, tank leak detection systems, spill and overfill protection, external pipe protection, secondary containment, and formal training for personnel. The USEPA has documented that the implementation of SPCC plans has a definable reduction in impacts based on the number of spills, spill volume, cleanup cost, and off-site migration (USEPA 1996). According to the USEPA study, “reduction” indicates that there is 95 percent confidence that SPCC provisions listed above have a positive effect on reducing the particular spill risk (e.g., leak detection reduces the number of spills).The implementation of a SPCC plan would not prevent spills entirely, but the risks would be reduced; therefore, impacts due to spills of petroleum products would be minor.

Under the 2-Unit Operation, the risk of a spill or release may decrease as compared to the 3-Unit Operation because one-third less hazardous materials would be used on-site. In the case of spills or releases of non-petroleum chemicals and products, NGS has an Emergency Response Plan. This plan covers procedures for handling spills, as well as other emergencies. Therefore, with implementation of the Emergency Response Plan in the event of a spill or release, impacts would be minor under either the 3-Unit Operation or 2-Unit Operation.

3.15.4.3.1.4 Summary of Risk

<u>Hazardous Materials, Chemicals, and Products</u>

Based on the 2010 U.S. Census, the main urban center closest to the plant, Page, Arizona, has a population of 7,247 (U.S. Census Bureau 2010). The prevailing winds at Page for most of the year are from the west (Western Regional Climate Center 2016). Given the prevailing winds and the recommended exclusion zones for a release of anhydrous ammonia, Page is not likely to be affected by a release at the plant or along the transportation routes. Outside of Page, the population is isolated and dispersed with the second largest population center being LeChee, with a 2010 population of 1,443 (U.S. Census Bureau 2010). Because Lechee is along the Coppermine Mine Road, which is a potential transportation route, it may have a slightly elevated exposure risk in case of a transportation incident. However, as discussed above, there is a low overall probability of a transportation incident. Based on the prevailing winds at Page, Lechee is located such that an airborne plume of anhydrous ammonia from the plant is not likely to affect the community. The SPCC and Emergency Response Plans and appropriate storage controls also would minimize potential risk and impacts. The impacts due to spills and releases of hazardous materials, chemicals and products would be minor.

<u>Solid Waste</u>

If not handled and disposed of properly, solid waste can have effects on human health and the environment (including air, soil, and water resources). The solid waste that is generated is either recycled, appropriately disposed off-site, or placed into permitted waste landfills on-site.

CCR Disposal

One of the largest waste streams consists of CCRs, which are placed into an on-site landfill and managed pursuant to the CCR regulations. The disposal of CCRs at NGS poses a small risk of impacts to the environment. The CCRs have stabilized to the point that samples from test holes of the original layers have shown to have compressive strength similar to lean concrete (**Appendix 1B**). Lean concrete is concrete with less cement than the standard concrete cement to water ratio. Although it does not have the strength of conventional concrete, it does indicate that the waste material has strength that helps to stabilize the material. Several factors also increase the stability and include the fact that not only is the material dry, run-on controls and compacted native soil cap prevent entry of moisture into the lifts of material. The arid climate also contributes to keeping the material dry. Because the material is dry, there would not be a tendency for leaching of harmful constituents like metals into groundwater. Also, the depth to groundwater is approximately 900 feet below the ground surface at the ash disposal facility (Section 3.7).

Under the 3-Unit Operation, it is possible that the landfill would have to be expanded to accommodate the estimated nearly 23 million cubic yards of CCRs. This also is dependent on how much fly ash could be marketed over the 2020 to 2044 time period (**Appendix 1B**). Expansion would require an additional 239 acres (Table 3.0-1) within the current area leased for the landfill. Under the 2-Unit Operation, there would be enough capacity in the permitted on-site landfill to operate from 2020 to 2044.

The recent USEPA revision of the disposal regulations for CCRs was motivated out of concern regarding the effects that surface impoundments and landfills could have on people and the environment if mismanaged. CCRs may contain contaminants, including heavy metals (mercury, cadmium and arsenic). If improperly managed, these contaminants can pollute surface water, groundwater, and the air. Although CCRs are not regulated as a hazardous waste, there are new requirements regarding certification, operating criteria, groundwater monitoring and corrective action, and closure and post-closure care. NGS would comply with those requirements that apply to the landfill as described in the *Navajo Generating Station: Coal Combustion Residuals Ash Disposal Landfill Requirements*, which is Appendix B of the Operations and Maintenance Plan (**Appendix 1B**). The new regulations for CCRs management would not affect the ability to market recyclable fly ash. In addition to the facility's current management of CCRs, the compliance with the new regulatory requirements noted above would provide an added level of protection and decreased risk of impacts to the environment and health and safety. Based on these requirements, as well as the compressive strength of the landfilled CCRs, the arid climate, soil cap and run-on controls, and depth to groundwater under the landfill, the impact of CCR disposal would be minor.

Other Solid Waste Disposal

The potential impacts from disposal of other solid waste would be much reduced because most of the other materials would be disposed of off-site. In addition, new policy was instituted in 2015 to strictly control materials that had previously gone into the landfill and disposal of all materials off-site (see **Appendix 1B**). The asbestos landfill would be kept open in order to receive waste generated during routine operation and maintenance, as well as potential shut down and demolition of facilities under the 2-Unit Operation. If operated in compliance with governing regulations, the asbestos landfill would present little risk of impacts to the environment, and therefore, the impact would be minor.

Site Closure and Decommissioning

Under the Proposed Action, the operating and support facilities at the plant site would be dismantled and demolished to ground level by the end of 2045, unless the Navajo Nation continues NGS operations beyond 2044. The overall decommissioning process is described in **Appendix 1B** and includes a discussion of closure of impoundments and CCR disposal facility.

As part of the decommissioning process, the following activities would take place with regard to hazardous materials and solid waste:

- A comprehensive Phase I Environmental Site Assessment (ESA) would be conducted to determine if there are any sources or paths of contamination and to identify environmental receptors and develop remedial alternatives if applicable. The Phase I ESA would consist of a records review, site visit, regulatory review, and hydrogeologic review to determine if environmental contamination, which may result in future environmental liability is likely to be present at the property.
- Phase II ESA would consist of on-site sampling to determine if environmental issues exist. A sampling and analysis plan would be developed to identify sample locations, sampling methodologies, analytical parameters, and a quality assurance plan.
- Equipment systems would be surveyed to verify that no fuels remain.
- Coal would be removed from storage areas, conveyors, hoppers, and feed equipment.
- Fuel oils would be drained and purged from tanks, piping, and pumping equipment.
- Sludge and residues would be removed and equipment cleaned.
- Glass, paper, cardboard, plastics, and metals would be recovered for recycling.
- Remediate any contaminated soils found during demolition.
- Plant native vegetation.

Except for hazardous materials and parts and material salvaged, recycled, or sold for scrap, it is anticipated that demolished structural material would be placed within a landfill area on the NGS site, and covered with soil. In accordance with Lease Amendment 1, the coal ash landfill would be left in place and capped with soil material, and revegetated. Hazardous materials would be transported and disposed in compliance with the RCRA and other applicable requirements. Decommissioning of the BM&LP Railroad would involve removal of overhead power lines, rails, and ties.

As required in the 1969 Lease, the land would be restored as closely as possible to original condition where the surface of any leased land has been modified or improved. The areas that do not contain permanent facilities would have all nonindigenous material removed from the surface and the area would be filled and graded in order to provide proper drainage; however, there would be no attempt to return the leased lands or the ROW to the preconstruction elevations. All restored land would be covered with topsoil indigenous to the area and revegetated with native plants to meet the lease requirements (**Appendix 1B**).

The decommissioning and closure activities would remove potentially hazardous materials from the site. In addition, the Phase I and II ESA's would determine if there are impacts to soil and groundwater and provide the basis for remediation of contaminants. The cleanup of soil and groundwater would be conducted under applicable federal, state, tribal regulations, lease obligations. The impacts due to closure and decommissioning would be negligible because removal and cleanup of potential contaminants would contribute to overall restoration of the site.

3.15.4.3.2 Proposed Kayenta Mine Complex

3.15.4.3.2.1 Public Safety and Noise

The impact analysis study area for the proposed KMC is detailed in Section 3.15.2. Regulatory changes in safety requirements would be included in standard operating procedures, and compliance with mandated safety rules would continue to be required. Blasting operations would continue to occur, and pre-blast surveys would be conducted as requested. Residents would continue to be notified and warned of blasting operations, and notification of the blasting would continue to be posted and advertised.

Blasting would continue to be monitored for air blast and ground vibration twice per year in June and December. PWCC would monitor airblast and ground vibration for all shots exceeding the scaled distance equation, as well as any required by the regulatory authority at their requested location. KMC's blasting records would continue to be monitored by OSMRE on a monthly to quarterly basis during field inspections.

Sensitive noise receptors, including residents who live near mine roads and within range of warning signals for blasting during mining operations, would continue to experience noise from mining activities. The number of warning and all-clear signals produced at blasting sites by an audible-speaker warning device of 100 watts or greater (audible at 0.5 mile) also would remain at or slightly below existing levels as overall coal production per year is not anticipated to increase, but may decrease under the 2-Unit Operation. Any sensitive receptors at 0.5 mile of construction activities would potentially incur noise ranging in sound levels from moderate rainfall to light automobile traffic (**Figure 3.15-1**). Natural topographic screening between mining operations and sensitive noise receptors could reduce noise for sensitive receptors. In addition to the distance of the sensitive noise receptors from the active mine areas, mining activities occur below grade, which result in the walls of the pit and spoil piles absorbing and attenuating some of the noise from mining activities. The noise reduction measures related to mining activities would include maintenance of equipment exhaust systems and engine sound controls to manufactures' specifications and limiting blasting to daylight hours. In addition to these measures, activity at the proposed KMC would stay the same or be incrementally reduced.

Vibration impacts were determined using the Blasting Guidance Manual, which was developed by OSMRE to prevent injury and damage to public and private property outside the mine permit area. OSMRE requires that airblast levels be limited to a maximum of 134 decibel (peak). Ground vibrations cannot exceed peak particle velocity of 1.25 inches per second at a distance of 300 feet or 0.75 inch per second at 5,000 feet (Rosenthal and Morlock 1987). There are three residences within or adjacent to current or future mining areas, one residence adjacent to mining area N-10, and two residences within N-11E. Because mining area N-10 would not be mined under the 2-Unit Operation, the residence in that area may not be affected.

Residents would be notified well in advance of the blasting schedule, and notices posted in public locations. Additionally, no blasting would be conducted within 0.5 mile of an occupied dwelling; therefore, residents in or near the blasting area would be evacuated prior to proceeding with any blasting actions. Temporary effects from vibration and airblast levels within standards established in 30 CFR Part 816.67 are not considered capable of producing injury or property damage, but could cause annoyance depending on the distance to the receptor (Mohamed 2010). Blasting activities would be conducted in accordance with administrative regulations established to minimize impacts resulting from noise and vibration in 30 CFR Part 816.67. Noise and vibration impacts would not be expected to exceed federal regulations detailed in Section 3.15.1, resulting in minor noise and vibration impacts levels. Section 3.16, Public Health, contains additional analysis related to noise and vibration.

Coal fires could occur in the mined cut, with the capability to spread to surrounding areas. Burning coal in these areas would be extinguished under the supervision of a qualified and certified Mine Safety Health Administration "Green Card" Surface Certified Supervisor in accordance with 30 CFR Part 816.87. Within 48 hours of its discovery, PWCC would commence efforts to extinguish any coal-related fire. If the fire is not extinguished within 96 hours after its discovery, PWCC would notify the BLM. Within 48 hours of notice, PWCC would submit to BLM a written report describing the extent of the fire, its exact location, the amount of recoverable coal affected, and any other information. The first response team at the mine site would have the ability to potentially control fires within the mine site before they spread outside the mine boundary. These first responders also would continue to serve the local residents under the Proposed Action.

The proposed realignment of Navajo Route 41 would straighten the road and make the route a more consistent elevation, eliminating a steep drop and curve where several accidents have occurred.

Under the Proposed Action, mining activities would cease in 2044 and public safety risks related to mining operations and blasting would be eliminated after decommissioning and reclamation activities are finalized. During the reclamation period, expected to take 2 to 3 years after cessation of mining, PWCC would continue to comply with all applicable federal, tribal, and state rules and regulations regarding health and safety and the handling and disposal of explosives and hazardous materials and wastes. Safety procedures regarding truck traffic would continue to be observed during reclamation activities, although fewer vehicles would be required for these activities. After the reclamation period, PWCC would no longer assist with Navajo Route 41 roadway maintenance or provide dust control measures. The realignment of Navajo Route 41 would be delayed. Emergency health care and first responder services provided by the mine would continue during the reclamation period but would cease following the completion of reclamation activities.

Noise and vibration effects associated with decommissioning would be limited to activities associated with removal of surface structures, facilities, and mining equipment, as well as reclamation activities. Mine-related noise and vibration effects would cease following the completion of decommissioning and reclamation.

3.15.4.3.2.2 Hazardous Materials, Chemicals, Products, and Solid Waste

The most used product at the KMC would be diesel fuel. Under the 3-Unit Operation diesel consumption would be 5.4 million gallons per year, and consumption under the 2-Unit Operation would be 4.2 million gallons per year. Based on the data in **Table 3.15-8**, the risk of a transportation incident would be low. The mine is required to have an SPCC Plan and an Emergency Response Plan to cover the storage, handling, and spill prevention and management of petroleum and hazardous materials. If an accident resulting in a release should occur, the impact would be anticipated to be negligible to minor depending on the location of the release.

If the proposed project is authorized to proceed, neither the type nor quantity of any wastes generated and disposed of by the mine would change. Solid and hazardous wastes would be disposed of off-site at approved facilities. Therefore, potential impacts would be negligible.

3.15.4.3.3 Transmission Systems and Communication Sites

3.15.4.3.3.1 Public Safety and Noise

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

The impact analysis study area for transmission systems and communication sites is detailed in Section 3.15.2. Typical average electric field readings for a 230-kV line and a 500-kV line at the edge of the study area (200 feet from ROW centerline) are 0.1 kV per meter and 0.6 kV per meter, respectively (**Table 3.15-7**). There are no federal standards for transmission line electric fields; however, the International Commission on Non-Ionizing Radiation Protection has set a voluntary protection level for electrical fields for the general public of 4.2-kV per meter (International Commission on Non-Ionizing Radiation Protection 1998). The average 230-kV line and 500-kV line electric field readings of approximately 0.1 kV per meter and 0.6 kV per meter at the edge of the study area are well below International Commission on Non-Ionizing Radiation Protection levels, resulting in negligible impact to sensitive receptors.

Typical homes produce background magnetic levels (away from appliances and wiring) that range from 0.5 milliGauss to 4 milliGauss, with an average value of 0.9 milliGauss (USEPA 1992). Natural static magnetic fields from the earth are near 0.6 milliGauss. Typical average magnetic field readings for a 230-kV line and 500-kV line at the edge of the study area (200 feet from ROW centerline) during average use are approximately 9 milliGauss and 20 milliGauss, respectively (**Table 3.15-7**). The International

Commission on Non-Ionizing Radiation Protection in a November 2010 release stated that the exposure limits for magnetic fields was 2,000 milliGauss for the public (International Commission on Non-Ionizing Radiation Protection 2010). The average magnetic field readings of both the 230-kV and 500-kV lines at the edge of the study area are well below International Commission on Non-Ionizing Radiation Protection levels, resulting in no impact to sensitive receptors.

Estimated 230-kV and 500-kV transmission line noise at the edge of the study area (200 feet from ROW centerline) is 20 dBA and 48 dBA, respectively, approximately the sound level of a soft whisper at 15 feet (20 dBA) or a moderate rain on foliage (48 dBA) (**Table 3.15-7**). This would result in negligible impact to sensitive receptors. There would be no change to transmission line noise levels under the Proposed Action from existing noise levels, as transmission line use would stay the same.

3.15.4.3.3.2 Hazardous Materials, Chemicals, Products, and Solid Waste

Under the Proposed Action, no new transmission line construction would take place, but operation and maintenance activities would continue. The major products used would consist of petroleum fuels and other materials related to vehicle maintenance and application of herbicides to control undergrowth along the ROW. The use of herbicides would be carefully monitored and controlled and applied by hand (**Appendix 1B**). Applications would take place periodically but not continually (for example once every 5 years). Empty containers would be returned to the suppliers and no materials would be left on-site. Impacts due to spills of herbicides are expected to be small to negligible due to the application measures and spill [prevention and clean-up measures described (**Appendix 1B**).

Maintenance activities that would be conducted on-site on an as-needed basis would include repair of equipment, vegetation control, fence repair, and access road repair. These activities would only require very small quantities of products. Impacts from the use of these products in the conduct of these repair and maintenance activities would be negligible.

3.15.4.3.4 Project Impact Summary – All Project Components

The project impact from the Proposed Action is anticipated to be negligible to moderate as a result of limited and in some cases no sensitive receptors within the respective study areas of the NGS and BM&LP Railroad, proposed KMC, and transmission lines and communication sites. Potential impacts would be reduced during decommissioning and reclamation and would cease following closure.

3.15.4.3.5 Cumulative Impacts

Past and present actions within the public safety and hazardous materials and solid waste cumulative impacts study areas include the former Black Mesa Mine and the existing NGS plant site and associated facilities and BM&LP Railroad, Kayenta Mine, and transmission system and communication sites. Operations at these sites began in the late 1960s and 1970s. Potential reasonably foreseeable future actions include the TransWest Express, Southern Nevada Intertie, and Eastern Nevada transmission lines that may be constructed in an existing West-Wide ROW adjacent to the WTS from the vicinity of Mesquite to the Eldorado Valley south of Las Vegas, Nevada, and segments of the Lake Powell water pipeline and transmission line that are proposed to overlap with the WTS utility corridor in Coconino County, Arizona, west of Lake Powell (**Figure 3.0-2**). Based on the Proposed Action analysis, the Proposed Action would not contribute to public safety or hazardous materials and solid waste cumulative impacts other than from a temporal standpoint, resulting from continued operations from 2019 to 2044.

3.15.4.4 Natural Gas Partial Federal Replacement Alternative

Under the Natural Gas Partial Federal Replacement (PFR) Alternative, a selected quantity of power between 100 megawatts (MW) and 250 MW would be contracted for under a long-term power purchase agreement from currently unidentified, existing natural gas generation sources, displacing an equivalent amount of power from the federal share of NGS generation.

3.15.4.4.1 Navajo Generating Station

Potential impacts to public safety associated with operation of NGS would be similar to those described for the 3-Unit Operation and 2-Unit Operation under the Proposed Action. The nearest noise sensitive receptors to the NGS are four scattered residences approximately 1 to 2 miles to the southeast near Arizona Highway 98, and a residence and the Navajo Nation Park Entrance located 0.5 mile south and 0.75 mile west, respectively, of the NGS pump station at Lake Powell. At these distances no noise impacts are anticipated at these sensitive receptors.

The frequency of potential impacts from BM&LP railroad operations would decrease for both the 3-Unit Operation and 2-Unit Operation since this alternative would require fewer round trips than under the Proposed Action; however, noise levels during times of operation would not change. Therefore, potential impacts would be minor.

The selective catalytic reduction units for the Natural Gas PFR Alternative would require less volume of anhydrous ammonia for pollution control as the 3-Unit Operation or 2-Unit Operation. Consequently, risks associated with the transportation, storage, and use of anhydrous ammonia (as well as other chemicals and products) would be less than the Proposed Action. Based on the low potential for a transportation incident rate (**Table 3.15-8**), there would be a low probability for a release under either operation. There also would be a low probability for a release of other chemicals and products. The potential for public health impacts would depend on the type of material released and the location of the release in relation to sensitive receptors.

CCR generation would be reduced for both the 3-Unit Operation and 2-Unit Operation because of reduced coal consumption. The risks associated with landfill disposal would be the same as for the Proposed Action and would be further reduced by compliance with new regulations as outlined in **Appendix 1B**.

The operating and support facilities at NGS would be dismantled and demolished to ground level by the end of 2045. Noise and vibration impacts associated with decommissioning of the NGS and BM&LP Railroad would be limited to removal of the operating and support facilities, and the overhead power lines, rails, ballast, ties, and structures, respectively. Noise from demolition also would include blasting from chimney removal and truck traffic for salvage material disposal. The nearest noise sensitive receptors to the NGS are four scattered residences approximately 1 to 2 miles to the southeast near Arizona Highway 98, and a residence and the Navajo Nation Park Entrance located 0.5 mile south and 0.75 mile west, respectively, of the NGS pump station at Lake Powell. At these distances no noise impacts are anticipated at these sensitive receptors.

3.15.4.4.2 Proposed Kayenta Mine Complex

Under the Natural Gas PFR Alternative, less coal would be mined at the proposed KMC than under the Proposed Action; however, blasting operations would continue as needed. Blasting-related noise and vibration impacts would not be expected to exceed federal regulations, resulting in minor noise and vibration impacts levels. These levels would be the same or less than under the Proposed Action.

Hazardous materials transportation, storage, and use and solid waste generation would be reduced commensurately with the reduction of mine operations. Impacts from hazardous materials and solid waste are expected to be negligible because of the low risks as described under the Proposed Action. Based on the low potential for a transportation incident rate (**Table 3.15-8**), there would be a minor probability for a release under either operation. The potential for public health impacts would depend on the type of material released and the location of the release in relation to sensitive receptors.

Mining activities would cease in 2044 and public safety risks related to mining operations and blasting would be eliminated after decommissioning and reclamation activities are finalized. During the reclamation period, expected to take 2 to 3 years after cessation of mining, PWCC would continue to comply with all applicable federal, tribal, and state rules and regulations regarding health and safety and the handling and disposal of explosives and hazardous materials and wastes. Safety procedures regarding truck traffic would continue to be observed during reclamation activities, although fewer vehicles would be required for these activities. After the reclamation period, PWCC would no longer assist with Navajo Route 41 roadway maintenance or provide dust control measures. The realignment of Navajo Route 41 would be delayed. Emergency health care and first responder services provided by the mine would continue during the reclamation period but would cease following the completion of reclamation activities.

Noise and vibration effects associated with decommissioning would be limited to activities associated with removal of surface structures, facilities, and mining equipment, as well as reclamation activities. Mine-related noise and vibration effects would cease following the completion of decommissioning and reclamation.

3.15.4.4.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

The average magnetic field readings of both the 230-kV and 500-kV lines at the edge of the study area are well below International Commission on Non-Ionizing Radiation Protection levels, resulting in no impact to sensitive receptors. Noise levels associated with transmission line use would result in negligible impacts to sensitive receptors. Impacts due to the transportation, storage, and use of hazardous materials and the generation of solid waste would be the same as the Proposed Action.

3.15.4.4.4 Project Impact Summary – All Project Components

The impacts from the Natural Gas PFR Alternative are expected to be negligible to minor. Potential impacts would be reduced during decommissioning and reclamation and would cease following closure.

3.15.4.4.5 Cumulative Impacts

Past and present actions within the public safety and hazardous materials and solid waste cumulative impacts study areas include the former Black Mesa Mine and the existing NGS plant site and associated facilities, and BM&LP Railroad, Kayenta Mine, and transmission system and communication sites. Operations at these sites began in the late 1960s and 1970s. Potential reasonably foreseeable future actions include the TransWest Express, Southern Nevada Intertie, and Eastern Nevada transmission lines that may be constructed in an existing West-Wide ROW adjacent to the WTS from the vicinity of Mesquite to the Eldorado Valley south of Las Vegas, Nevada, and segments of the Lake Powell water pipeline and transmission line that are proposed to overlap with the WTS utility corridor in Coconino County, Arizona, west of Lake Powell (**Figure 3.0-2**). Based on the analysis above, the NGS, proposed KMC, and their associated transmission systems and communication sites would not contribute to public safety or hazardous materials and solid waste cumulative impacts other than from a temporal standpoint, resulting from continued operations from 2019 to 2044.

3.15.4.5 Renewable Partial Federal Replacement Alternative

Under the Renewable PFR Alternative, a selected quantity of power between 100 MW and 250 MW would be contracted for under a long-term power purchase agreement from a currently unidentified, existing renewable energy power source, displacing an equivalent amount of power from the federal share of NGS generation.

3.15.4.5.1 Navajo Generating Station

Potential impacts to public safety associated with operation of NGS would be similar to those described for the 3-Unit Operation and 2-Unit Operation under the Proposed Action. The nearest noise sensitive receptors to the NGS are four scattered residences approximately 1 to 2 miles to the southeast near Arizona Highway 98, and a residence and the Navajo Nation Park Entrance located 0.5 mile south and 0.75 mile west, respectively, of the NGS pump station at Lake Powell. At these distances no noise impacts are anticipated at these sensitive receptors.

The frequency of potential impacts from BM&LP railroad operations would decrease for both the 3-Unit Operation and 2-Unit Operation since this alternative would require fewer round trips than under the Proposed Action; however, noise levels during times of operation would not change. Therefore, potential impacts would be minor.

The selective catalytic reduction units would require less anhydrous ammonia for pollution control for the 3-Unit Operation. Consequently, risks associated with the transportation, storage, and use of anhydrous ammonia (as well as other chemicals and products) would be the same as the Proposed Action. Based on the low potential for a transportation incident rate (**Table 3.15-8**), there would be a low probability for a release under either operation. There also would be a low probability for a release of other chemicals and products. The potential for public health impacts would depend on the type of material released and the location of the release in relation to sensitive receptors.

CCR generation would be reduced for both the 3-Unit Operation and 2-Unit Operation because of reduced coal consumption. The risks associated with landfill disposal would be the same as for the Proposed Action and would be further reduced by compliance with new regulations as outlined in **Appendix 1B**.

Decommissioning impacts would be similar to the Proposed Action and the Natural Gas PFR Alternative.

3.15.4.5.2 Proposed Kayenta Mine Complex

Under the Renewable PFR Alternative, less coal would be mined at the proposed KMC than under the Proposed Action; however, blasting operations would continue as needed. Blasting-related noise and vibration impacts would not be expected to exceed federal regulations, resulting in minor noise and vibration impacts levels.

Hazardous materials transportation, storage, and use and solid waste generation would be reduced commensurately with the reduction of mine operations. Impacts from hazardous materials and solid waste are expected to be negligible because of the low risks as described under the Proposed Action. Based on the low potential for a transportation incident rate (**Table 3.15-8**), there would be a minor probability for a release under either operation. The potential for public health impacts would depend on the type of material released and the location of the release in relation to sensitive receptors.

Decommissioning impacts would be similar to the Proposed Action and the Natural Gas PFR Alternative.

3.15.4.5.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

The average magnetic field readings of both the 230-kV and 500-kV lines at the edge of the study area are well below International Commission on Non-Ionizing Radiation Protection levels, resulting in no impact to sensitive receptors. Noise levels associated with transmission line use would result in negligible impacts to sensitive receptors. Impacts due to the transportation, storage, and use of hazardous materials and the generation of solid waste would be the same as the Proposed Action.

3.15.4.5.4 No Action Impact Summary – All Project Components

The impacts from the Renewable PFR Alternative are expected to be negligible to minor. Potential impacts would be reduced during decommissioning and reclamation and would cease following closure.

3.15.4.5.5 Cumulative Impacts

Past and present actions within the public safety and hazardous materials and solid waste cumulative impacts study areas include the former Black Mesa Mine and the existing NGS plant site and BM&LP Railroad, Kayenta Mine, and transmission system and communication sites. Operations at these sites began in the late 1960s and 1970s. Potential reasonably foreseeable future actions include the TransWest Express, Southern Nevada Intertie, and Eastern Nevada transmission lines that may be constructed in an existing West-Wide ROW adjacent to the WTS from the vicinity of Mesquite to the Eldorado Valley south of Las Vegas, Nevada, and segments of the Lake Powell water pipeline and transmission line that are proposed to overlap with the WTS utility corridor in Coconino County, Arizona, west of Lake Powell (**Figure 3.0-2**). Based on the analysis above, the NGS, proposed KMC, and their associated transmission systems and communication sites would not contribute to public safety or hazardous materials and solid waste cumulative impacts other than from a temporal standpoint, resulting from continued operations from 2019 to 2044.

3.15.4.6 Tribal Partial Federal Replacement Alternative

Under the Tribal PFR Alternative, between 100 MW and 250 MW of power generation from the NGS would be replaced by power supplied by a new photovoltaic generation facility on tribal land, displacing an equivalent amount of power from the federal share of NGS generation. The construction of a new photovoltaic generation site on tribal land would result in between 1,200 and 3,000 acres of new surface disturbance. The Tribal PFR facility would be analyzed in a separate National Environmental Policy Act process once a facility location is identified.

3.15.4.6.1 Navajo Generating Station

Potential impacts to public safety associated with operation of NGS would be similar to those described for the 3-Unit Operation and 2-Unit Operation under the Proposed Action. The nearest noise sensitive receptors to the NGS are four scattered residences approximately 1 to 2 miles to the southeast near Arizona Highway 98, and a residence and the Navajo Nation Park Entrance located 0.5 mile south and 0.75 mile west, respectively, of the NGS pump station at Lake Powell. At these distances no noise impacts are anticipated at these sensitive receptors.

The frequency of potential impacts from BM&LP railroad operations would decrease for both the 3-Unit Operation and 2-Unit Operation since this alternative would require fewer round trips than under the Proposed Action; however, noise levels during times of operation would not change. Therefore, potential impacts would be minor.

The selective catalytic reduction units would require the lessanhydrous ammonia for pollution control for the 3-Unit Operation. Consequently, risks associated with the transportation, storage, and use of anhydrous ammonia (as well as other chemicals and products) would be less than the Proposed Action. Based on the low potential for a transportation incident rate (**Table 3.15-8**), there would be a low probability for a release under either operation. There also would be a low probability for a release of other chemicals and products. The potential for public health impacts would depend on the type of material released and the location of the release in relation to sensitive receptors.

CCR generation would be reduced for both the 3-Unit Operation and 2-Unit Operation because of reduced coal consumption. The risks associated with landfill disposal would be the same as for the

Proposed Action and would be further reduced by compliance with new regulations as outlined in **Appendix 1B**.

Decommissioning impacts would be similar to the Proposed Action.

3.15.4.6.2 Proposed Kayenta Mine Complex

Under the Tribal PFR Alternative, less coal would be mined at the proposed KMC than under the Proposed Action; however, blasting operations would continue as needed. Blasting-related noise and vibration impacts would not be expected to exceed federal regulations, resulting in minor noise and vibration impacts levels that would be the same or less than historical levels associated with the Kayenta Mine.

Hazardous materials transportation, storage, and use and solid waste generation would be reduced commensurately with the reduction of mine operations. Impacts from hazardous materials and solid waste are expected to be negligible because of the low risks as described under the Proposed Action. Based on the low potential for a transportation incident rate (**Table 3.15-8**), there would be a minor probability for a release under either operation. The potential for public health impacts would depend on the type of material released and the location of the release in relation to sensitive receptors.

Decommissioning impacts would be similar to the Proposed Action.

3.15.4.6.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

The average magnetic field readings of both the 230-kV and 500-kV lines at the edge of the study area are well below International Commission on Non-Ionizing Radiation Protection levels, resulting in no impact to sensitive receptors. Noise levels associated with transmission line use would result in negligible impacts to sensitive receptors. Impacts due to the transportation, storage, and use of hazardous materials and the generation of solid waste would be the same as the Proposed Action.

3.15.4.6.4 Project Impact Summary – All Project Components

The impacts from the Tribal PFR Alternative are expected to be negligible to minor.

3.15.4.6.5 Cumulative Impacts

Past and present actions within the public safety and hazardous materials and solid waste cumulative impacts study areas include the former Black Mesa Mine, the existing NGS site and BM&LP Railroad, Kayenta Mine, and transmission system and communication sites. Operations at these sites began in the late 1960s and 1970s. Potential reasonably foreseeable future actions include the TransWest Express, Southern Nevada Intertie, and Eastern Nevada transmission lines that may be constructed in an existing West-Wide ROW adjacent to the WTS from the vicinity of Mesquite to the Eldorado Valley south of Las Vegas, Nevada, and segments of the Lake Powell water pipeline and transmission line that are proposed to overlap with the WTS utility corridor in Coconino County, Arizona, west of Lake Powell (**Figure 3.0-2**). Based on the analysis above, the NGS, proposed KMC, and associated transmission systems and communication sites would not contribute to public safety or hazardous materials and solid waste cumulative impacts other than from a temporal standpoint, resulting from continued operations from 2019 to 2044. Cumulative impacts associated with the new photovoltaic generation facility would be analyzed in a separate National Environmental Policy Act action document once a location for the facility is identified.

3.15.4.7 No Action

3.15.4.7.1 Navajo Generating Station

Under the No Action Alternative, decommissioning activities would begin in 2018 with effective shutdown of the plant occurring by the end of 2019. The decommissioning and closure activities would be same as the Proposed Action and impacts would be negligible. The operating and support facilities at the plant site would be dismantled and demolished to ground level; however, the water supply facilities, and certain buildings and equipment would remain. Noise and vibration impacts associated with decommissioning of the NGS and BM&LP Railroad would be limited to removal of the operating and support facilities, and the overhead power lines, rails, ballast, ties, and structures, respectively. Noise from demolition also would include blasting from chimney removal and truck traffic for salvage material disposal. The nearest noise sensitive receptors to the NGS are four scattered residences approximately 1 to 2 miles to the southeast near Arizona Highway 98, and a residence and the Navajo Nation Park Entrance located 0.5 mile south and 0.75 mile west, respectively, of the NGS pump station at Lake Powell. At these distances no noise impacts are anticipated at these sensitive receptors.

Under the No Action Alternative, transportation and use of hazardous materials and the generation of solid wastes would be greatly reduced. This reduction would result in a much lower probability for impacts to public safety and the environment during decommissioning and reclamation; potential impacts would be anticipated to be negligible. The potential for impacts would cease following the completion of these activities.

3.15.4.7.2 Proposed Kayenta Mine Complex

Under the No Action Alternative, mining activities would cease and public safety risks related to mining operations and blasting would be eliminated. During the reclamation period, expected to take 2 to 3 years after cessation of mining, PWCC would continue to comply with all applicable federal, tribal, and state rules and regulations regarding health and safety and the handling and disposal of explosives and hazardous materials and wastes. Safety procedures regarding truck traffic would continue to be observed during reclamation activities, although fewer vehicles would be required for these activities. After the reclamation period, PWCC would no longer assist with Navajo Route 41 roadway maintenance or provide dust control measures. The realignment of Navajo Route 41 would be delayed. Emergency health care and first responder services provided by the mine would continue during the reclamation period, but would cease following the completion of reclamation activities.

Noise and vibration effects under the No Action Alternative would be limited to activities associated with removal of surface structures, facilities, and mining equipment, as well as reclamation activities. Mine-related noise and vibration effects would be less than under the Proposed Action and would cease following the completion of decommissioning and reclamation.

Under the No Action Alternative, reclamation activities would consume diesel fuel and products used for equipment maintenance; however, the consumption would be at a much lower rate over a much shorter time period compared to the Proposed Action. This reduction in use would result in a much lower probability for impacts to public safety and the environment during decommissioning and reclamation; the potential for impacts would be considered to be negligible. The potential for impacts would cease following the completion of these activities.

3.15.4.7.3 Transmission Systems and Communication Sites

The NGS transmission system is an established part of the western U.S. transmission grid and supports reliability and delivery of power throughout the region, well beyond the power generated by the NGS. Therefore, under the No Action Alternative it is likely that that one, several, or all of the land owners/managers of the transmission line rights-of-way and communication site leases would renew some portion of the facilities to keep the power grid performing as expected.

In the event it is determined that some or all of the transmission systems and communication site ROWs are not renewed, a lengthy study and permitting process would need to occur before any decommissioning is initiated due to the essential and integral nature of these facilities with the western electric grid. As noted in Section 2.3.3, up to 4,826 acres within and alongside the transmission system corridors could be temporarily disturbed if the entirety of the transmission systems and communication sites were decommissioned and removed.

3.15.4.7.4 Project Impact Summary – All Project Components

Under the No Action, it is anticipated that impacts would be negligible during decommissioning and reclamation and would cease following these activities, with one exception. Impacts associated with ongoing operation of the transmission systems and communication sites would be anticipated to be negligible.

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Section 3.16

Public Health and Human Health Risk Assessment

Please note: Language referring to time frames in this section is consistent with the Human Health Risk Assessment. The term “Future Operations” refers to the time frame associated with the Proposed Action (i.e., 2020 through 2044).

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Acronyms and Abbreviations

μg/dl	micrograms per deciliter
μg/m^3	micrograms per cubic meter
1969 Lease	Navajo Project Indenture of Lease
ADHS	Arizona Department of Health Services
AGFD	Arizona Game and Fish Department
ALA	American Lung Association
BART	Best Available Retrofit Technology
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BM&LP Railroad	Black Mesa & Lake Powell Railroad
BO	Biological Opinion
BRFSS	Behavioral Risk Factor Surveillance System
CAP	Central Arizona Project
CDC	Center for Disease Control
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CO_2	carbon dioxide
COPC	chemical of potential concern
Co-tenants	Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
dBA	A-weighted decibels
Development Fund	Lower Colorado River Basin Development Fund
DPM	diesel particulate matter
EIS	Environmental Impact Statement
EMS	Emergency Medical Service
EPRI	Electric Power Research Institute
ERA	Ecological Risk Assessment
ESA	Endangered Species Act of 1973
HHRA	Human Health Risk Assessment
HHRAP	Human Health Risk Assessment Protocol
HI	Hazard index
HQ	Hazard quotient
ICMM	International Council on Mining and Metals
IEUBK	Integrated Exposure Uptake Biokinetic Model for Lead in Children
IUR	Inhalation Unit Risk
km	kilometer
KMC	Kayenta Mine Complex
kV	kilovolt
kW	kilowatt
MW	megawatt

N-Aquifer	Navajo Aquifer
NAAQS	National Ambient Air Quality Standards
NEC-NDOH	Navajo Epidemiology Center-Navajo Department of Health
NEPA	National Environmental Policy Act of 1969, as amended
NGS	Navajo Generating Station
NGS Participants	U.S. (Reclamation), Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
NHPA	National Historic Preservation Act
NNEPA	Navajo Nation Environmental Protection Agency
NO_2	nitrogen dioxide
NO_X	nitrogen oxide
NRC	National Research Council of the National Academies
OSMRE	Office of Surface Mining Reclamation and Enforcement
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 microns or less
PFR	Partial Federal Replacement
PWCC	Peabody Western Coal Company
Reclamation	U.S. Bureau of Reclamation
ROW	Right-of-way
SCR	Selective Catalytic Reduction
SO_2	sulfur dioxide
SRP	Salt River Project Agricultural Improvement and Power District
STS	Southern Transmission System
tpy	Tons per year
U.S.	United States
USEPA	U.S. Environmental Protection Agency
WHO	World Health Organization
WTS	Western Transmission System

Contents

3.16 Public Health and Human Health Risk Assessment 3.16-1
3.16.1 Regulatory Framework 3.16-1
3.16.2 Overview 3.16-1
3.16.2.1 Public Health 3.16-1
3.16.2.2 Human Health Risk Assessment 3.16-7
3.16.3 Study Areas 3.16-9
3.16.3.1 Proposed Action and Action Alternatives 3.16-9
3.16.3.2 Cumulative 3.16-10
3.16.4 Affected Environment 3.16-10
3.16.4.1 Navajo Generating Station HHRA 3.16-10
3.16.4.2 Proposed Kayenta Mine Complex HHRA 3.16-14
3.16.4.3 Transmission Systems and Communications Sites 3.16-19
3.16.4.4 Public Health 3.16-20
3.16.5 Environmental Consequences 3.16-34
3.16.5.1 Issues 3.16-34
3.16.5.2 Assumptions and Impact Methodology 3.16-34
3.16.5.3 Proposed Action 3.16-35
3.16.5.4 Natural Gas Partial Federal Replacement Alternative 3.16-59
3.16.5.5 Renewable Partial Federal Replacement Alternative 3.16-62
3.16.5.6 Tribal Partial Federal Replacement Alternative 3.16-65
3.16.5.7 No Action 3.16-67
3.16.6 References 3.16-71

List of Tables

Table 3.16-1 Summary of Public Health Approach: Health Categories Selected for Public Health Evaluation 3.16-4

Table 3.16-2 NGS Baseline HHRA Result 3.16-13

Table 3.16-3 NGS Baseline HHRA Blood Lead Model Results 3.16-14

Table 3.16-4 Proposed KMC Baseline Risk Case Result 3.16-17

Table 3.16-5 Proposed KMC Baseline Risk Case Blood Lead Model Results For the Resident Farmer Child 3.16-18

Table 3.16-6 Coconino and Navajo Counties Health Ranking within Arizona 3.16-23

Table 3.16-7 Leading Causes of Death in Coconino and Navajo Counties 3.16-25

Table 3.16-8 Leading Causes of Death Among Navajo 3.16-26

Table 3.16-9 General Health Status Among Chinle Agency, U.S., and Arizona Populations 3.16-27

Table 3.16-10 Definitions of Health Impact Categories 3.16-34

Table 3.16-11 Comparison of NGS Baseline and Proposed Action HHRA Results 3.16-38

Table 3.16-12 Comparison of NGS Baseline and Proposed Action Blood Lead Model Results 3.16-39

Table 3.16-13 NGS HHRA Results: Baseline and Future Operations 3.16-40

Table 3.16-14 Comparison of Proposed KMC Baseline to Proposed Action Risk Cases for Resident, Gardener, and Farmer Exposure Scenarios 3.16-42

Table 3.16-15 Proposed Project Public Health Impacts 3.16-47

Table 3.16-16 NGS HHRA 3-Unit Operation Results for Total Cumulative Impacts 3.16-57

Table 3.16-17 NGS HHRA 2-Unit Operation Results for Total Cumulative Impacts 3.16-57

Table 3.16-18 Proposed KMC HHRA Results for Total Cumulative Impacts 3.16-58

Table 3.16-19 NGS HHRA Results: Baseline and Other Cumulative Sources 3.16-68

Table 3.16-20 Summary of Proposed KMC HHRA Results – Baseline and Other Cumulative Sources (No Action) 3.16-69

List of Figures

Figure 3.16-1 Navajo Generating Station Air Monitoring 50-km Near-field Study Area 3.16-11
Figure 3.16-2 Proposed KMC Residential and Reclaimed Land Surficial Soil Sampling Locations..........3.16-16
Figure 3.16-3 Demographic Regions..........3.16-21
Figure 3.16-4 Navajo Generating Station at Proposed KMC Grid Cell 3.16-44

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3.16 Public Health and Human Health Risk Assessment

The Public Health and Human Health Risk Assessment (HHRA) section describes the potential direct, indirect, and cumulative effects on public health (both positive and negative) and potential human health risks associated with the Proposed Action, other action alternatives, and the No Action Alternative.

The public health evaluation assesses the potential health impacts on the local populations within a 50-kilometer (km) radius of the Navajo Generating Station (NGS), including the area downwind of the NGS and proposed Kayenta Mine Complex (KMC). It provides an assessment of the current health conditions of the potentially affected communities, including the existing environmental conditions and public health resources within the communities that could be affected.

3.16.1 Regulatory Framework

The National Environmental Policy Act (NEPA) requires an integrated analysis of health effects be addressed when an environmental impacts analysis is conducted. The public health and HHRA evaluations fulfill this requirement and evaluates the potential impacts to public health associated with the proposed project alternatives. All worker health issues are covered under the Occupational Safety and Health Act and Federal Mine Safety and Health Act.

The public health analysis follows National Research Council (National Research Council of the National Academies [NRC] 2011) and the North American Health Impact Assessment Practice Standards Working Group (2010) guidelines for assessing public health impacts of potential projects.

The HHRAs summarized in this section were conducted in accordance with standard U.S. Environmental Protection Agency (USEPA) risk assessment methodology, including Risk Assessment Guidance for Superfund, Volume I (Parts A, B, E, and F) (USEPA 2009a, 2004a, 1991, 1989) and the HHRA Protocol (HHRAP) for Hazardous Waste Combustion Facilities (USEPA 2005). Additional guidance documentation includes the following:

- User's Guide for the AMS/USEPA Regulatory Model - AERMOD. USEPA-36 454/B-03-001. U.S. Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency. Research Triangle Park, North Carolina. September (USEPA 2004b)
- USEPA NONROAD Model. Office of Transportation and Air Quality. USEPA-420-F-09-020. April (USEPA 2009a)
- Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK), Windows version (win v1.1 build11) February (USEPA 2010)
- Exposure Factors Handbook (USEPA 2011)
- USEPA online regional screening levels (USEPA 2015)

3.16.2 Overview

3.16.2.1 Public Health

Public health is the science of protecting and improving the health of families and communities through promotion of healthy lifestyles, research for disease and injury prevention, and detection and control of infectious diseases. Public health is concerned with protecting the health of entire populations; these populations can range from local neighborhoods to entire regions of the world. Public health also works to limit health disparities by promoting healthcare equity, quality, and accessibility.

Public health is related to incidences and death rates for infectious and chronic diseases or other health conditions, including mental health. It can be affected by environmental conditions as well as demographics (such as poverty and minority status), the availability of health care services, and the prevalence of behavioral and social problems (see Section 3.18, Socioeconomics, and Section 3.19, Environmental Justice).

This section describes the approach used to evaluate potential effects on public health associated with the proposed project. The National Research Council guidance (NRC 2011) lists five general areas that should be addressed as part of a public health evaluation to systematically select the issues that need to be addressed for a particular project. These five areas are environment, economy, infrastructure, services, and demographics. Five categories of health impacts are assessed for each area (NRC 2011):

- Chronic Disease: For the purposes of this evaluation, chronic diseases are considered to be health conditions that persist for long periods of time (e.g., 3 months or longer) and are non-communicable, such as heart disease, cancer, or asthma.
- Infectious Disease: Infectious diseases are considered to be associated with viral, bacterial or microbial infections and are commonly communicated from person to person through direct contact, such as influenza or malaria.
- Injury: Unintentional or accidental event resulting in injury or trauma, such as a car accident or fall.
- Nutrition: Impacts to health (positive or negative) associated with diet.
- Well-being/Psychosocial Effects: Well-being and psychosocial effects consider the social, cultural, and well-being of the populations.

The potential for health impacts associated with the Proposed Action and Partial Federal Replacement (PFR) action alternatives are considered irrespective of the baseline environmental/community health conditions and geographic scope. The rationale for the selection of areas with health issues that may be relevant to the Proposed Action, and the rationale for the exclusion of areas with no or negligible impacts to health, is provided in the following subsections. Section 3.16.4 evaluates the affected environment as it relates to the categories selected for further consideration. Section 3.16.5 evaluates the magnitude of the potential health issues selected for further evaluation (both positive and negative) on the local community and the cumulative impacts over baseline conditions.

Additional information relevant for evaluating public health in the project vicinity was compiled (Gradient 2016) and used as supporting documentation of health-related information throughout the public health evaluation. This additional information includes data from air monitoring stations within and in the vicinity of the project area, information regarding the health status and availability of health services.

3.16.2.1.1 Environment and Health

Impacts to the environment typically are evaluated by environmental media (air, soil, groundwater, and surface water). Specifically, this section asks the question “will chemicals be emitted from the Proposed Action and enter environmental media at levels that could be a health concern?”

Health concern is evaluated by considering the amount of human exposure to potentially impacted environmental media. Human exposure to environmental media can occur through several pathways of exposure (e.g., inhalation of vapors or particulates in air, incidental ingestion or dermal contact with impacted soils, ingestion or dermal contact with impacted groundwater or surface water, etc.). The HHRAs directly address the health effects associated with exposure to chemicals released to the environment from the Proposed Action and PFR action alternatives. The public health evaluation considers the potential impacts to air quality from the Proposed Action and PFR action alternatives.

The release of particulate matter (PM), particularly $PM_{2.5}$, to the air and its possible effects on the local population is discussed in detail in Section 3.16.4. Two specific types of PM associated with NGS-KMC operation, diesel exhaust emissions and coal dust emissions, are discussed in further detail. In addition, the burning of coal in homes, as commonly practiced by Navajo peoples, as a source of PM via indoor air to the Navajo people also is discussed.

3.16.2.1.2 Economy and Health

Economic impacts may have indirect impacts on health, due to more or less financial resources available to the local population or local government health-related services. Section 3.18 discusses the socioeconomic conditions of the project area and the impacts that Proposed Action operations would have on the existing socioeconomic conditions.

3.16.2.1.3 Public Services/Infrastructure and Health

Changes in public services and infrastructure can have direct or indirect health benefits or consequences. For example, health benefits can occur if new water or sanitation systems reduce disease incidence rates for the local community. Or, there may be negative impacts if new roads or transit corridors increase accidents or negatively impact access to health-related services or activities.

3.16.2.1.4 Demographics and Health

The characteristics of the existing population are directly relevant to assessing potential impacts. For this project, local demographics and land use patterns were evaluated as well as the health status of the local community. Potential human health impacts selected for analysis that are relevant to land use are:

- Potential impacts to lands used for livestock grazing;
- Potential relocation of residents living within the mining zone;
- Disturbance of cultural resources that might affect traditional tribal lifestyles; and
- Noise and vibration disturbances during mine blasting.

In addition to a local community's land use, the local population's health status is relevant, as some populations are especially sensitive to the effects of particulate inhalation due to a pre-existing health condition, such as asthma or diabetes (American Academy of Pediatrics 2004; Jaspers et al. 2009; O'Neill et al. 2007, 2005). Populations with pre-existing conditions that could be worsened by air pollution also may be at increased risk of infectious complaints if their underlying health condition is worsened (Kelly and Fussell 2011). Some recent information has found that air pollution, specifically including diesel exhaust, may be associated with causing asthma in children (Patel and Miller 2009), in addition to exacerbating the condition if already present. However, this is an on-going area of research and the role of various components of air pollution (e.g., ozone and nitrogen oxide versus particulates) and a causal relationship with asthma is not clear (Kelly and Fussell 2011). In addition, populations without health insurance and those in poor health due to socioeconomic conditions may be particularly adversely affected either because their baseline health is poorer (sensitive sub-population) or their ability to receive medical care when they need it is compromised (Gresenz and Escarce 2011; Hadley 2003; Hadley and Cunningham 2005; Newton et al. 2008) (see Section 3.18, Socioeconomics, and Section 3.19 Environmental Justice, for additional discussion).

3.16.2.1.5 Summary of Public Health Approach

For this Environmental Impact Statement, potential public health impacts with regard to environment, economy, demographics and community health were considered for NGS and/or the proposed KMC. No new public infrastructure or changes to existing public services are anticipated under the Proposed Action and PFR action alternatives. **Table 3.16-1** summarizes the approach to the public health evaluation.

Table 3.16-1 Summary of Public Health Approach: Health Categories Selected for Public Health Evaluation

Potentially Affected Categories	Project Area	Project Specifics	Possible Health Impacts				
			Chronic Disease	Infectious Disease	Injury	Nutrition	Well-being or Psychosocial
Environment							
Air	NGS	Stack emissions from NGS operations; secondary emissions and fugitive dust from plant and ash disposal area; diesel emissions from vehicle traffic.	**(PN)** Inhalation of criteria and hazardous air pollutants	**(PN)** Inhalation of criteria and hazardous air pollutants	None	None	**(PN)** Inhalation of criteria and hazardous air pollutants
		Deposition impacts from air emission.	**(PN)** Direct contact with hazardous pollutants	**(PN)** Direct contact with hazardous pollutants	None	**(PN)** Uptake of hazardous pollutants through consumption of livestock, fish, and/or garden/home grown foods.	**(PN)** Direct contact with hazardous pollutants
	Proposed KMC	Fugitive dust and particulate emissions from bulk coal during mining operations; diesel emissions from vehicle traffic and machinery	**(PN)** Inhalation of particulate emissions	**(PN)** Inhalation of particulate emissions	None	None	**(PN)** Inhalation of particulate emissions
		Deposition impacts from air emission.	**(PN)** Direct contact with hazardous pollutants	**(PN)** Direct contact with hazardous pollutants	None	**(PN)** Uptake of hazardous pollutants through consumption of livestock, fish, and/or garden and home grown foods.	**(PN)** Direct contact with hazardous pollutants

Table 3.16-1 Summary of Public Health Approach: Health Categories Selected for Public Health Evaluation

Potentially Affected Categories	Project Area	Project Specifics	Possible Health Impacts				
			Chronic Disease	Infectious Disease	Injury	Nutrition	Well-being or Psychosocial
Economy							
Personal (income, employment)	NGS and proposed KMC	Increase in local employment	**(PP)** Increased access to health care	**(PP)** Increased access to health care	None	**(PP)** Increased access to healthy foods	**(PP)** Positive impacts due to job opportunities
Revenue or expense to local, state, or tribal government (support for or drain on services, infrastructure)	NGS and proposed KMC	Increased funds to Navajo and Hopi through extension of lease and coal royalties	**(PP)** Positive impacts due to increased revenue stream	**(PP)** Positive impacts due to increased revenue stream	None	**(PP)** Positive impacts due to increased revenue stream	**(PP)** Positive impacts due to increased revenue stream
Public Services and Infrastructure							
Need for new infrastructure	NGS and proposed KMC	None	None	None	None	None	None
Demand on existing infrastructure	NGS and proposed KMC	None	None	None	None	None	None
New and continuing public services as direct result of proposal	NGS and proposed KMC	Continued access to emergency medical service (EMS) from Peabody Western Coal Company (PWCC) clinic	**(PP)** Continued access to health care	**(PP)** Continued access to health care	None	None	**(PP)** Continued access to health care
Drain on existing services resulting from Proposed Action	NGS and proposed KMC	No impacts on local services are expected.	None	None	None	None	None

Table 3.16-1 Summary of Public Health Approach: Health Categories Selected for Public Health Evaluation

Potentially Affected Categories	Project Area	Project Specifics	Possible Health Impacts: Chronic Disease	Infectious Disease	Injury	Nutrition	Well-being or Psychosocial
Demographics							
Land use patterns (residential, recreational, or tribal use patterns)	NGS	No changes to land use patterns are anticipated	None	None	None	None	None
	Proposed KMC	Potential impacts to lands used for livestock grazing Potential relocation of residents living within the mining zone. Disturbance of cultural resources that might affect traditional tribal lifestyles Noise and vibration disturbances during mine blasting	None	None	None	**(PN)** Effects on livestock, fish, and/or garden/home grown foods	**(PN)** Psychological effects due to relocation **(PN)** Disturbance of cultural resources **(PN)** Psychological effects due to noise and vibration
Community Health	NGS and proposed KMC	Potential effects to sensitive sub-populations (e.g., exacerbation of asthma, impacts on lung/heart disease rates)	**(PN)** Inhalation of particulate emissions	**(PN)** Inhalation of particulate emissions	None	None	**(PN)** Inhalation of particulate emissions

(**PN**) Indicates selected for evaluation, possible negative effect.

(**PP**) Indicates selected for evaluation, possible positive effect.

3.16.2.2 Human Health Risk Assessment

To assist in the qualitative assessment of impacts to public health, HHRAs can be conducted for defined study areas. A HHRA is a quantitative technical method used to estimate potential exposures, hypothetical cancer risks, and potential noncancer adverse health effects from measured or estimated levels of chemicals. HHRAs can be performed to evaluate past, current, and even future exposures to chemicals found in air, soil, water, food, consumer products or other materials. See Section 3.0 for additional descriptions of the methodologies used in the HHRAs.

HHRAs rely on a scientific understanding of pollutant behavior, human exposure, dose, and toxicity and produce estimates of hypothetical health risks for a receptor population. A HHRA cannot determine whether a current health problem or symptom was caused by a specific exposure to a specific chemical. Other types of information are needed to evaluate potential causal links between exposures and human health effects, e.g., results from human epidemiology studies. To evaluate potential links, scientists or doctors may conduct epidemiological studies of specific communities or populations. Toxicity studies can be used to explore exposure levels, types of health endpoints, and mechanisms of action associated with specific chemical exposures, while epidemiological studies can survey the occurrence of health endpoints in a specific group and can compare observations in that group with those in relevant groups (e.g., individuals in other cities, communities, or the population as a whole).

Additional information relevant for evaluating public health in the project vicinity was compiled (Gradient 2016) and used as supporting documentation of health-related information throughout this section. This additional information includes data from air monitoring stations within and in the vicinity of the project area, information regarding the health status and availability of health services, and information obtained from scientific literature relating to health effects associated with substances assessed in the HHRAs.

Although both HHRAs and epidemiological studies focus on potential health impacts in human populations, they have different objectives. Epidemiological studies can evaluate whether past chemical exposures may be associated with documented health effects in a specific group of people. In contrast, HHRAs are used to estimate the type and degree of potential health risks posed by past, current, or future chemical exposures in a specific population and exposure setting, such as a local community.

Epidemiology studies of the study area population were not conducted as part of this Environmental Impact Statement because they take many years to complete. Instead, information relevant for evaluating public health in the project vicinity was compiled (Gradient 2016) and used as supporting documentation of health-related information throughout this section. This additional information includes data from air monitoring stations within and in the vicinity of the project area, information regarding the health status and availability of health services and information obtained from scientific literature relating to health effects associated with substances assessed in the HHRAs.

HHRAs for the two study areas (NGS and proposed KMC) were performed as separate evaluations considering study area-specific receptors and sampling data. HHRAs for the two study areas evaluated baseline conditions (i.e., existing site conditions measured in 2014 and considered representative of historical operations through 2019) and several sets of future scenarios relating to the Proposed Action, combined impacts from the NGS and proposed KMC projects on each other, and other cumulative sources scenario. The baseline HHRAs assessed the human health impacts due to exposure to existing on-the-ground environmental conditions on December 22, 2019; i.e., the potential human health risk during the time period of operation of the project but due to the effect of the baseline conditions. The results of the baseline risk assessments for NGS and proposed KMC are presented in Section 3.16.4.1 and 3.16.4.2, respectively.

Sampling data for the NGS and proposed KMC baseline HHRAs were collected in 2014 and are considered representative of study area conditions as of December 22, 2019, primarily because soil data concentrations near NGS and proposed KMC are less than regional or national background levels after

40 years of operation and other potential non-project related impacts. This suggests that soil concentrations are at an equilibrium and the 5-year lag period is unlikely to significantly change concentrations (Flatirons Toxicology, Inc. 2015; Ramboll Environ 2016a).

The future operation HHRAs evaluated scenarios related to the proposed action with data obtained from air modeling. Two scenarios were modeled to represent the future operations at NGS (i.e., conditions predicted in the vicinity of the facilities as a result of future facility operations and emissions). Future Operations scenarios were selected to represent the highest and lowest potential environmental impacts (i.e., air emissions). The two operations (3-Unit, 2,250-megawatt [MW] output and 2-Unit, 1,500-MW output) are based on USEPA's July 2014 Best Available Retrofit Technology (BART) Rule to achieve reductions in emissions of nitrogen oxides at NGS. Additional detail on each Future Operations scenario is presented in the NGS Baseline HHRA (Ramboll Environ 2016a). Results of the risk assessments for the 3-Unit Operation (representing highest nitrogen oxide emissions) and 2-Unit Operation (representing lowest nitrogen oxide emissions) scenarios are presented in Section 3.16.5.

The proposed KMC HHRA modeled two Future Operations risk cases using maximum and minimum predicted rates of coal production. These Future Operations risk cases are based on mining rates of 8.1 million tons per year (tpy) and 5.5 million tpy, to represent maximum and minimum rates, respectively. Results of the risk assessments and impacts on human health for the 8.1 million tpy and 5.5 million tpy operations are presented in Section 3.16.5.3.

Incremental upper-bound lifetime cancer risks and noncancer hazard indexes (HIs) for individuals who may reside, work, or recreate in the vicinity of NGS - and individuals who reside within and in the vicinity of the proposed KMC - mine permit area were estimated for the Baseline, Proposed Action, and Other Cumulative Sources risk cases.

The HHRAs calculated incremental lifetime cancer risks and noncancer HQs for each chemical of potential concern (COPC) for each potentially exposed population. For carcinogens, the risks were estimated as the incremental probability of an individual developing cancer over a lifetime as a result of the specified exposure occurring over the defined exposure interval. The cumulative cancer risk estimates (the summation of the calculated result for each chemical) were compared to USEPA acceptable incremental risk range of 1×10^{-4} (one hundred in a million) to 1×10^{-6} (one in one million).[1] If estimated hypothetical cancer risks are within this range, then no further evaluation was required.

An HHRA cancer risk estimate of 1×10^{-6}, or one in one million, means that in a population of one million people, not more than one additional person would be predicted to develop cancer as the result of the evaluated exposure. Regulators generally define a one-in-one million to 100 in one million lifetime cancer risk range due to exposure to a chemical or group of chemicals for a specified duration integrated over a lifetime to be within an "acceptable risk" risk range. This acceptable regulatory risk range is extremely low compared to the overall cancer rate one out of every two (male) or three (female) in the United States or an approximately 40 percent (or 4×10^{-1}) average lifetime risk of being diagnosed with cancer (American Cancer Society 2015).

[1] It is standard practice to express cancer risks in scientific notation. Scientific notation can be used to convert 0.0001 into 1×10^{-4} by moving the decimal place until you have a whole number between 1 and 10. If you keep moving the decimal place to the right four places in 0.0001 you will get 1. The number of places you moved the decimal point determines the negative exponent (E). In this case, the decimal point was moved four places to get to the whole number of 1 and can be expressed as 1×10^{-4}. A larger negative exponent indicates a smaller number, which is important when comparing cancer risks to the USEPA acceptable risk range. A cancer risk of 3×10^{-7} represents a number that is less than the risk range of 1×10^{-4} to 1×10^{-6}, and is considered acceptable risk. A cancer risk of 4×10^{-3} represents a number that is greater than the risk range, and is considered unacceptable risk.

The potential for noncancer adverse health effects was determined by comparing an estimated level of exposure to a chemical to the level of exposure that is not expected to cause any adverse effects (e.g., asthma, birth defects, nervous system disorders), even in susceptible or sensitive individuals (USEPA 1989). The ratio between the estimated exposure level and these comparison values (called reference doses or reference concentrations) and the estimated exposure level or concentration yields for each chemical a simple ratio referred to as a Hazard Quotient (HQ), a quantitative estimate of noncancer health effects. The HQ for all COPCs were then summed to derive a HI. If the sum of all the HQs (i.e., HI) was less than 1, then the exposures were considered to be acceptable for noncancer risk and no further risk calculations or evaluations were warranted.

Lead does not have standard toxicity values so health hazards from exposure to lead cannot be estimated using the same risk assessment methodology as other chemicals. USEPA recommends lead hazards be evaluated based on blood lead concentrations in children, which are estimated using the IEUBK model (USEPA 2010). Predicted blood lead concentrations were compared to the Center for Disease Control (CDC) recommended reference blood level of 5 micrograms per deciliter (µg/dl) and the USEPA recommended reference blood level of 10 µg/dl. If they were less than these reference levels, exposure to lead was considered acceptable and no further risk calculations or evaluations were necessary.

The details of the HHRA methodology are described in the NGS Baseline HHRA (Ramboll Environ 2016a) and the proposed KMC Baseline HHRA (Flatirons Toxicology, Inc. 2015). The analysis followed the Risk Assessment Guidance for Superfund (USEPA 1989) and HHRAP; (USEPA 2005), procedures established by the USEPA which are comprised of the following steps:

- Hazard Identification (identification of chemicals of potential concern);
- Dose-Response Assessment (toxicity criteria for cancer and noncancer health effects are identified);
- Exposure Assessment (identification of potentially exposed populations, development of exposure scenarios and exposure pathways, estimation of exposure point concentrations, and calculation of intakes by various exposure routes);
- Risk Characterization (provide estimates of potential cancer risk and noncancer hazard to human health from exposure to COPCs); and
- Uncertainty Analysis (discuss the uncertainty associated with methods and assumptions used in the risk assessment and how these uncertainties may either increase or decrease the magnitude of potential risks).

3.16.3 Study Areas

3.16.3.1 Proposed Action and Action Alternatives

3.16.3.1.1 Human Health Risk Assessment

The study areas for the HHRAs include the area up to 50 km from the NGS (**Figure 3.16-1**) and up to a distance of approximately 50 km from the center of the proposed KMC lease permit boundary, as reflected in the dispersion modeling that was used to evaluate impacts.

3.16.3.1.2 Public Health

The study area for the public health evaluation consists of the local community, including members of the Navajo Nation and the Hopi Reservation within northern Coconino and Navajo counties, Arizona, particularly the Navajo Mountain Chapter (of the Western Agency) and portions of the Hopi Reservation surrounding NGS and the Kayenta Chapter (of the Western Agency) surrounding the proposed KMC, as well as the nearby off-reservation communities in the two counties, including Page, Arizona (**Figure 3.16-3**).

3.16.3.2 Cumulative

3.16.3.2.1 Human Health Risk Assessment

The cumulative study area for the HHRA is the same as the HHRA study area for the Proposed Action and alternatives.

3.16.3.2.2 Public Health

The cumulative study area for the public health evaluation is the same as the public health evaluation study area for the Proposed Action and alternatives.

3.16.4 Affected Environment

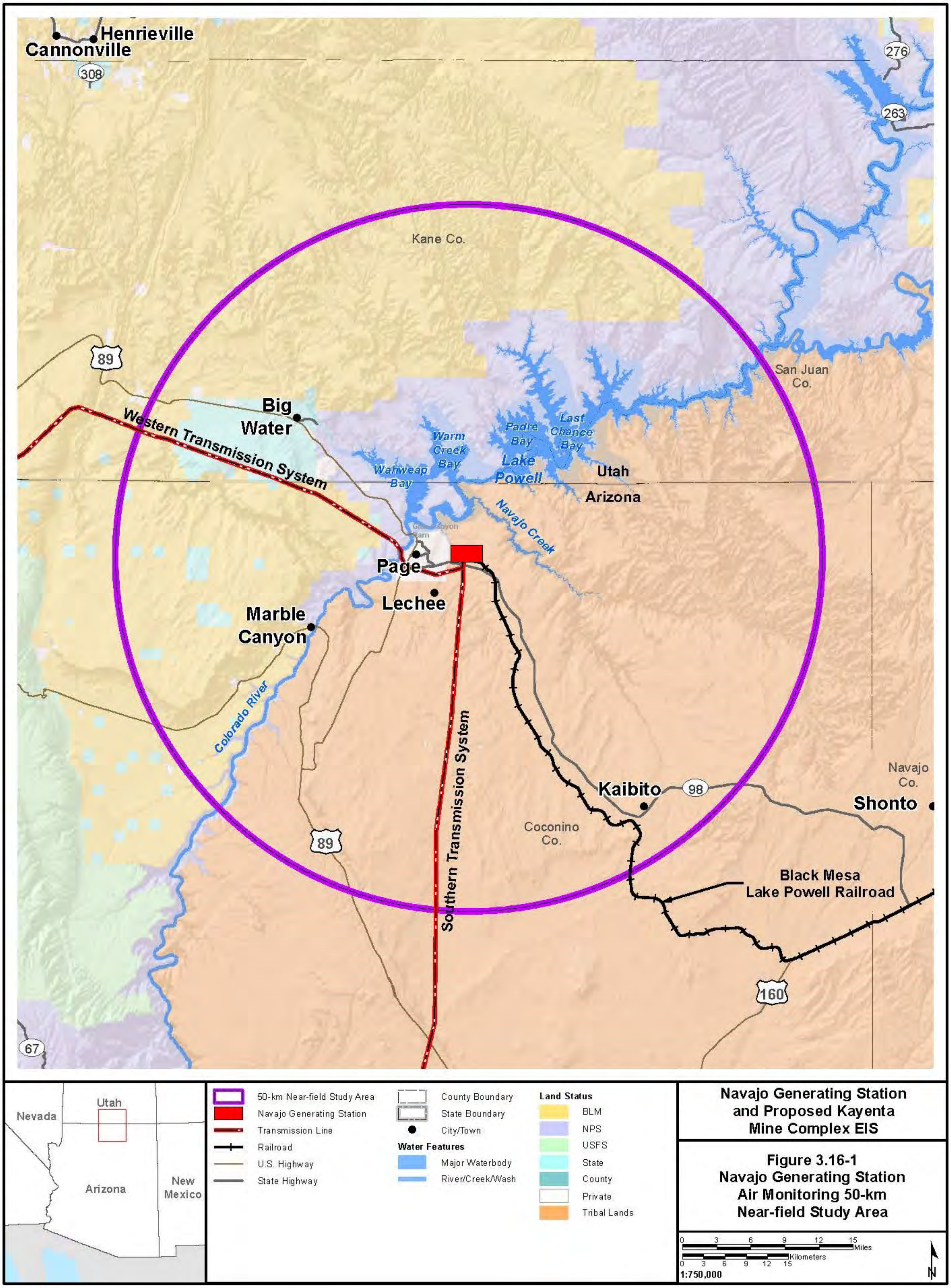
The baseline HHRAs provide data and methods to evaluate the affected environment in terms of potential human health risk from baseline conditions. For specific substances of interest for facility emissions (e.g., air emissions of metals from various aspects of NGS and proposed KMC operations), these analyses generated chemical-specific quantitative estimates of potential human health risk associated with various exposure pathways. In accordance with standard risk assessment guidance and practice, these analyses focused on broad categories of potential health effects such as cancer and noncancer effects (Flatirons Toxicology, Inc. 2015; Gradient 2016; Ramboll Environ 2016a). The human health risk estimates for baseline conditions for the NGS are summarized in Section 3.16.4.1 and for the proposed KMC in Section 3.16.4.2. The transmission systems and communications sites potential exposures relative to human health are discussed in Section 3.16.4.3.

The public health evaluation includes an assessment of the current public health conditions of the potentially affected community, including the existing environmental conditions and public health and safety resources within the community that could be affected by the proposed project (Section 3.16.4.4).

3.16.4.1 Navajo Generating Station HHRA

NGS is a coal-fired electric power generating station located in northern Arizona on the Navajo Reservation, about 3 miles east of the City of Page on approximately 1,020 acres of land leased from the Navajo Nation. **Figure 3.16-1** shows the NGS and associated 50-km Near-field study area. Based on the preliminary assessment of the surrounding community, along with information received from Navajo Nation, and USEPA’s HHRAP's recommendation, the following receptors and exposure pathways were considered in the baseline HHRA at the NGS:

- Off-site Resident – This scenario evaluated potential residential (adult and child) exposure resulting from incidental ingestion of soil, dermal contact with soil, inhalation of volatiles and resuspended particulate from soil, and ingestion of breast milk (infant only).
- Off-site Resident Gardener – This scenario evaluates potential residential (adult and child) exposure resulting from incidental ingestion of soil, dermal contact with soil, inhalation of volatiles and resuspended particulate from soil, ingestion of breast milk (infant only) and ingestion of homegrown produce.
- Off-site Resident – Farm Family – This scenario evaluated potential exposures for residential farming residents (adult and child) who live outside Page, Arizona. The same exposure pathways evaluated for the off-site resident gardeners were evaluated for the farm families with the additional pathway of livestock (lamb) ingestion. The farm family scenario increased exposure to soil associated with farming activities and used higher ingestion rates for homegrown produce.



Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 3.16-1 Navajo Generating Station Air Monitoring 50-km Near-field Study Area

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7/19/2016

- Off-site Commercial Worker – This scenario evaluated potential commercial/industrial exposures resulting from incidental ingestion of soil, dermal contact with soil, and inhalation of volatiles and resuspended particulate from soil.
- Off-site Recreational User (adult and child) – This scenario evaluated incidental ingestion of and dermal contact with surface water and sediment while swimming or wading. This scenario also evaluated incidental ingestion of and dermal contact with surface water and sediment while fishing, and ingestion of fish taken from waterbodies (i.e., Lake Powell and Colorado River).

Exposure due to traditional activities and lifestyles for local Navajo Nation tribe members could occur through medicinal or ceremonial uses of native herbs or, as well as other uses of native plants such as yucca for making shampoo. Exposures through these activities were not evaluated quantitatively at the NGS for three reasons. First, the consumption rate of native herbs likely would be significantly lower compared to local consumption of other homegrown produce in terms of quantity and exposure frequency and therefore would be accounted for in the exposure evaluation for homegrown produce. Second, gathering of native herbs for medicinal or ceremonial purposes is not a common practice within the study area. Lastly, the herbs used for medicinal or ceremonial uses are not from locations within the NGS study area (Ramboll Environ 2016a).

Baseline conditions represent the existing on-the-ground environmental conditions on December 22, 2019, which includes natural conditions and any pollutants produced by past NGS operations and other local, regional, and global emission sources that have accumulated. The baseline risk assessment evaluated the potential human health risk due to the effect of these baseline conditions.

3.16.4.1.1 Chemicals of Potential Concern

COPCs identified for quantitative evaluation in the NGS HHRA included pollutants typically emitted from coal-fired electric generating units based on two previous studies conducted by the Electric Power Research Institute (EPRI 2011, 2009) and diesel particulate matter (DPM) emitted from other on-site sources (e.g., trucks). A few additional metals (aluminum, boron, cobalt, copper, iron, and vanadium) were added based on the coal composition data collected during the Kayenta Mine Sampling Investigation in 2014 (Ramboll Environ 2016c). The COPCs quantitatively evaluated in the NGS baseline HHRA included metals, polychlorinated dibenzodioxins, polychlorinated dibenzofurans, polycyclic aromatic hydrocarbons, volatile organic compounds, and some other inorganics.

COPCs that are not persistent in the environment, normally only exist in vapor phase, or only have human health impact through the inhalation pathway were not evaluated for baseline (which includes historic operations) in the HHRA. These chemicals include elemental mercury, acrolein, benzene, sulfuric acid, hydrogen chloride, hydrogen fluoride, nitrogen dioxide, sulfur dioxide, carbon monoxide, and DPM. These chemicals are not likely to accumulate in the environment and their ambient air concentrations would soon be consistent with surrounding regions once NGS ceases operation (Ramboll Environ 2016a). Although not included in the baseline HHRA evaluation, they were evaluated in the HHRA for future operation scenarios.

Exposure point concentrations represent the concentration of each chemical that an individual may be exposed to at a given receptor location. Exposure point concentrations were used together with pathway-specific intake equations to calculate the exposure (dose) attributable to each chemical of potential concern. For the Baseline scenario for NGS HHRA, 95 percent upper confidence limits on the mean of the soil, surface water, and sediment data were used as the exposure point concentrations. COPC concentrations in homegrown produce, lamb, fish and breast milk were estimated based on soil, surface water, and sediment exposure point concentrations following recommended approaches from the USEPA's HHRAP.

3.16.4.1.2 Risk Characterization

As presented in **Table 3.16-2**, the results of the NGS Baseline HHRA show that potential cancer risks due to existing on-the-ground conditions for the off-site resident, off-site resident gardener, off-site resident farmer, recreational user, and commercial worker are within the USEPA acceptable risk range of 1 x 10^{-4} (1 in 10,000) to 1 x 10^{-6} (1 in 1,000,000). For noncancer effects, the NGS Baseline HHRA reported that the HIs for all receptors were equal to or less than the USEPA benchmark of 1. The estimated HI for a recreational user child is the highest of all receptors at 1.2, due to exposure of methyl mercury via fish consumption in Lake Powell. Note that the Arizona Game and Fish Department issued a fish consumption advisory in 2012 recommending that people, including pregnant women and children, limit their consumption of striped bass caught in the southern portion of Lake Powell (Arizona Game and Fish Department [AGFD] 2012). The estimated average daily doses for infants exposed to dioxins/furans through ingestion of breast milk were well below the national exposure level of 60 picograms Toxic Equivalency Quotient/kilogram/day.

Table 3.16-2 NGS Baseline HHRA Result

Receptor	Cancer Risk	Hazard Index	Breast Milk Average Daily Dose (pg/kg-bw/day)
Resident	2E-06	0.1	0.27
Resident-Gardener	5E-06	0.7	0.45
Resident-Farm Family	4E-05	0.8	1.9
Recreational User	4E-06	1.2[1]	NA
Commercial Worker	5E-07	0.02	NA
Benchmark[2]	1E-04 to 1E-06	1	60

[1] The HI of 1.2 for the child recreational user is due to exposure to methyl mercury via the consumption of fish.

[2] Cancer risk estimates within or less than the benchmark cancer risk range are considered acceptable and require no further evaluation. HIs less than the target HI of 1 are considered acceptable and require no further evaluation. For dioxins and furans in breast milk, an average daily dose less than 60 pg/kg-bw/day is considered acceptable and requires no further evaluation.

pg/kg-bw/day = picograms per kilogram-body weight per day.

As presented in **Table 3.16-3**, the estimated blood lead concentrations were well below both the USEPA target blood lead level of 10 micrograms per deciliter (µg/dL) and the CDC reference blood lead concentration of 5 µg/dL. When risk estimates and/or dioxin/furan and lead concentrations are less than their respective benchmarks, no further evaluation is necessary. The Baseline HHRA concluded that negligible impact on human health was identified based on the baseline conditions in the vicinity of NGS. The Baseline HHRA also concluded that given the degree of conservatism purposefully built into the risk assessment methods and benchmarks, this conclusion is highly protective of public health.

Table 3.16-3 NGS Baseline HHRA Blood Lead Model Results

Receptor	Geometric Mean of Blood Lead Level (µg/dL)	Percent >10 µg/dL
Resident	0.84	<0.001
Resident-Gardener	0.82	<0.001
Resident-Farm Family	0.95	<0.001
Benchmark[1]	5 (CDC reference blood lead level) 10 (USEPA benchmark blood lead level)	

[1] If receptor modeled lead levels are less than the CDC (5 µg/dL) and USEPA (10 µg/dL) blood lead level benchmarks, then modeled blood lead levels are considered acceptable and require no further evaluation.

CDC = Centers for Disease Control.

µg/dL = micrograms per deciliter.

3.16.4.1.3 Uncertainty Analysis

Key uncertainties associated with the estimated exposures and risks for potentially exposed populations in the vicinity of NGS include chemical of potential concern selection, toxicity values, exposure point concentrations, exposure parameters (e.g., food consumption rates), exposure pathways, and the 5-year lag period. The uncertainty associated with chemical of potential concern selection, toxicity values, exposure point concentrations, exposure parameters and the 5-year lag period is low, and it is likely that the HHRA outcome results in overestimates of exposure because of the generally conservative nature of inputs. Additional discussion regarding this uncertainty is provided in the NGS Baseline HHRA (Ramboll Environ 2016a).

The uncertainty associated with exposure pathways, specifically the exposure to the farm family through consumption of lamb, is considered high. The default livestock species evaluated in the HHRAP are beef, pork and chicken (USEPA 2005). However, the primary livestock consumed within the NGS study area is lamb (Ramboll Environ 2016a). Because no specific consumption rates for lamb were provided in the NGS HHRAP, consumption rates for beef were utilized. To account for the difference in the livestock species evaluated vs. consumed available bio-transfer factors were estimated for lamb and used in the NGS HHRA. Bio-transfer factors were not available for some chemicals of potential concern (mostly metals), such as arsenic. Consequently, potential risks for these chemicals of potential concern were not quantitatively evaluated, and risks for the livestock ingestion pathway likely are underestimated. Bio-transfer factors were not available for some chemicals of potential concern (mostly metals), such as aluminum, antimony, arsenic, barium, beryllium, chromium, cobalt, iron, lead, manganese, molybdenum, nickel, vanadium, and zinc. Consequently, potential risks for these chemicals of potential concern were not quantitatively evaluated, and risks for the livestock ingestion pathway likely are underestimated. Driving pathways for the overall risk (i.e., primary contributors to potential risk) for cancer and noncancer risk estimates for the resident farmer are ingestion of homegrown produce, ingestion of lamb and incidental ingestion of soil. Metals not evaluated for the lamb ingestion pathway, including arsenic, are evaluated for the residents for the homegrown produce and soil ingestion pathways.

3.16.4.2 Proposed Kayenta Mine Complex HHRA

The proposed KMC is an active coal-mining site located in northeast Arizona that has been in continuous operation for over 40 years. The proposed KMC permit area is approximately 62,930 acres and is located about 110 miles northeast of Flagstaff, Arizona, and 15 miles southwest of Kayenta, Arizona. The receptor population for the proposed KMC HHRA was defined as nearby residents located at various areas in and around the mine permit area. No other sensitive receptor sub-populations were identified in or around the mine permit area. The following receptors were considered in the HHRA at the proposed KMC:

- Resident – This scenario evaluated potential residential (adult and child) exposure resulting from incidental ingestion of soil, dermal contact with soil, and inhalation of resuspended soil particulates.
- Resident Gardener – This scenario evaluates potential residential (adult and child) exposure resulting from incidental ingestion of soil, dermal contact with soil, inhalation of resuspended soil particulates, and ingestion of homegrown produce.
- Resident – Farm Family – This scenario evaluates potential residential (adult and child) exposure resulting from incidental ingestion of soil, dermal contact with soil, inhalation of resuspended soil particulates, and ingestion of homegrown produce and livestock (beef).

The proposed KMC HHRA calculated hypothetical cancer risks and potential for noncancer health effects for four types of risk cases. These risk cases included Baseline, Proposed Action, Combined Impacts (NGS-KMC), and other cumulative sources.

Baseline conditions represent the existing on-the-ground environmental conditions on December 22, 2019. Baseline conditions include naturally occurring soil constituents, as well as any anthropogenic (human-caused) contributions from local, regional, and global emission sources, including past mining operations.

3.16.4.2.1 Chemicals of Potential Concern

COPCs in proposed KMC fugitive dust include metals (overburden/coal) and polycyclic aromatic hydrocarbons (coal). Criteria pollutants (particulate matter, carbon monoxide, ozone, sulfur dioxide, nitrogen dioxide, and lead) are generated in the course of some mining operations and are addressed in terms of compliance with National Ambient Air Quality Standards in the air monitoring report (McVehil-Monnett Associates, Inc. 2016). Lead also was identified as a chemical of potential concern and was evaluated quantitatively in the HHRA. Diesel particulate matter is a component of diesel emissions from heavy diesel equipment used in mine operations, and was considered a chemical of potential concern in the proposed KMC HHRA.

For the proposed KMC Baseline risk case (Flatirons Toxicology, Inc. 2015), soil sampling data collected in summer 2014 (Ramboll Environ 2016c) as part of the proposed KMC HHRA Field Sampling Plan Addendum (Flatirons Toxicology, Inc. 2014) were used to evaluate Baseline exposure conditions in 2019. Significant changes in soil concentrations between 2014 and 2019 are unlikely because soil concentrations were generally within background range for Arizona. Rapid changes in COPC concentrations are extremely unlikely over a 5-year period. Consequently, 2014 sample data are considered to be representative of 2019 conditions (Flatirons Technology, Inc. 2015). For residential areas, 19 composite samples from the surface soil (0 to 3 inches) were collected within and outside the proposed KMC (**Figure 3.16-2**). These locations represent a variety of potential factors that may determine exposure from past KMC, NGS, and other local, regional, and global sources, and future proposed KMC activities, as well as potential impacts from NGS operations. These factors included source area types, wind directions, and proximity to source areas (Flatirons Toxicology, Inc. 2014). An additional 8 surface soil samples collected from 7 reclaimed land parcels used for livestock grazing also were collected to evaluate potential exposure from this pathway. Overburden and coal samples at proposed KMC were collected to characterize metal and polycyclic aromatic hydrocarbon concentrations and used as inputs into the air dispersion and deposition modeling of fugitive dust emissions from mining operations to evaluate the Proposed Action scenarios in the HHRA. A total of 10 coal samples and 8 overburden samples were collected in accordance with the proposed KMC Field Sampling Investigation Report (Ramboll Environ 2016c).

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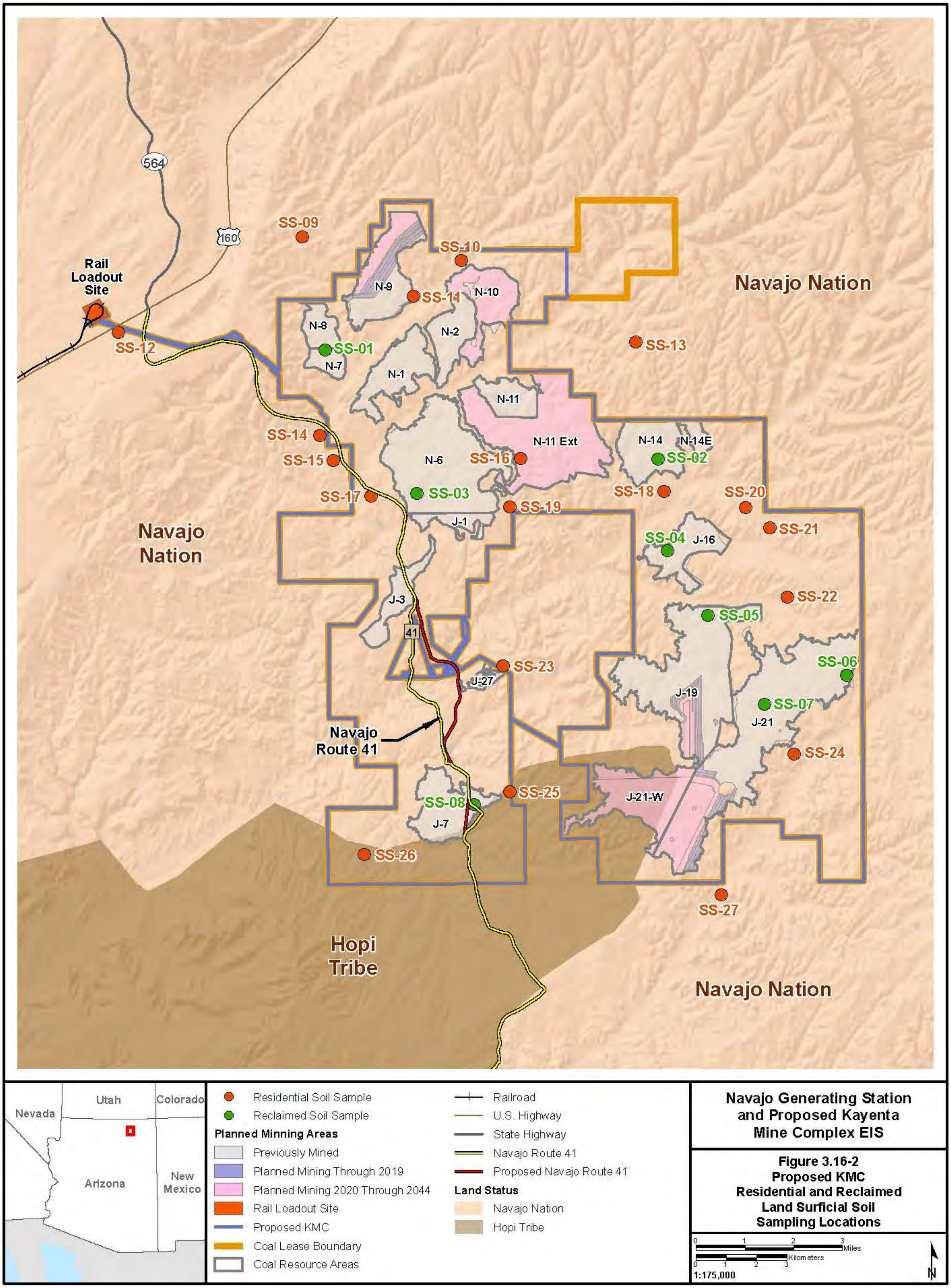

Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 3.16-2
Proposed KMC
Residential and Reclaimed
Land Surficial Soil
Sampling Locations

7/19/2016

3.16.4.2.2 Risk Characterization

As presented in **Table 3.16-4**, the results of the proposed KMC Baseline HHRA show that potential cancer risks due to existing on-the-ground conditions for the resident, resident gardener, and resident farmer are within the USEPA acceptable risk range of 1 x 10^{-4} (one in ten thousand) to 1 x 10^{-6} (one in one million). The HI for the resident-gardener and resident-farmer exceeded 1. When a HI exceeds 1, a target organ analysis is performed. A target organ analysis evaluates chemicals that have similar modes of toxicological action or similar impacts on an organ or system of the body (e.g., the liver, kidney, or nervous system). Such chemicals are grouped together to calculate a target organ-specific HI. Calculating risk based on a target organ analysis reduces the possibility of overestimating risk by summing HQs for a mixture of chemicals that are not expected to induce the same types of effects on a specific target organ. For noncancer effects, the HHRA reported that all receptor HIs or target organ-specific HIs were less than the USEPA benchmark of 1 (see **Table 3.16-4** footnotes).

Table 3.16-4 Proposed KMC Baseline Risk Case Result

Receptor	Cancer Risk	Hazard Index
Resident	6E-06	0.9
Resident-Gardener	9E-06	1.1[1]
Resident-Farmer	2E-05	1.9[2]
Benchmark[3]	1E-04 to 1E-06	1

[1] A HI of 1.1 for the resident gardener child exceeded the target HI of 1 and required further evaluation consisting of a target organ analysis. The conclusions of the target organ analysis performed for the resident farmer child also apply to the resident gardener child.

[2] A HI of 1.9 exceeded the target HI of 1 and required further evaluation consisting of a target organ evaluation. Because the target organ evaluation for the resident farmer child exposure scenario demonstrated all target organ HI were acceptable, a similar evaluation was not performed for any other scenario or receptors.

[3] Cancer risk estimates within or less than the benchmark cancer risk range are considered acceptable and require no further evaluation. HIs less than the target HI of 1 are considered acceptable and require no further evaluation.

For the proposed KMC baseline risk case, a total of five carcinogenic chemicals of potential concern were identified: arsenic, beryllium, cobalt, cadmium, and nickel. The primary risk driver for cancer risks for all exposure scenarios, receptors, and exposure pathways was arsenic. Arsenic accounted for virtually 100 percent of the potential cancer risk estimates.

The results of the noncancer risk show that the HI for the resident-gardener and resident-farmer exceeded 1The majority of the noncancer risk was due to five metals; aluminum, arsenic, cobalt, iron, and manganese. These metals accounted for approximately 87 to 92 percent of the reported noncancer risk HIs, depending on exposure scenario. While these five metals drive the noncancer risk estimates in the proposed KMC baseline HHRA, they are not included in the NGS baseline HHRA livestock ingestion pathway (due to lack of a bio-transfer factor for lamb) for the resident farmer. The inclusion of these metals accounts for higher baseline HI for the resident farmer at proposed KMC. The resident gardener child HI was slightly greater than the target HI of 1. Evaluation of target organ HQs is discussed below for the resident farmer child exposure scenario. The same conclusions for the resident farmer child target organ evaluation apply to the resident gardener child HI.

It is not uncommon for a HI to exceed 1, especially with a large number of chemicals of potential concern, because even if the individual HQs are well below 1, summing a large number of small HQs can lead to a HI greater than 1. For example, if each of the 20 chemicals of potential concern evaluated for the proposed KMC HHRA had a HQ of 0.1, the HI would be 2.0 and greater than the target HI.

However, exceedance of an initial HQ or HI by itself does not necessarily mean that the exposure is unacceptable. It simply indicates that further evaluation is necessary (USEPA 1989).

Because the HI for the resident farmer child and the resident gardener child exceeded 1, it was necessary to perform a target organ analysis to determine if any target organ HI exceeded 1. A summary of the target organs and HQs/HIs for the proposed KMC chemicals of potential concern for the resident farmer child is presented in the proposed KMC HHRA (Flatirons Toxicology, Inc. 2015). Because the target organ evaluation for the resident farmer child exposure scenario demonstrated that all target organ HQs and HIs were acceptable, a similar evaluation was not performed for any other scenarios or receptors (because the resident farmer exposure scenario had greater estimated exposures than the other resident scenarios). A detailed discussion of the target organ analysis process and the analysis performed for the resident farmer child at proposed KMC is presented in the proposed KMC HHRA (Flatirons Toxicology, Inc. 2015).

Lead was evaluated separately for noncancer health risk using the USEPA's Integrated Exposure Uptake Biokinetic Model (USEPA 2010), which allows evaluation of lead exposure in children. As presented in **Table 3.16-5**, predicted blood lead levels for children aged 0 to 7 years ranged from 0.2 to 0.4 µg/dL. The current CDC recommendation for reference blood levels in 1- to 5-year old children is 5.0 µg/dL (CDC 2012). This reference level reflects lead exposure levels that are considered elevated relative to typical levels in U.S. children in the same age range. The proposed KMC predicted blood levels were well below the CDC and USEPA reference blood levels. The probability of exceeding the CDC reference level was less than 0.0001 percent (Flatirons Toxicology, Inc. 2015).

Table 3.16-5 Proposed KMC Baseline Risk Case Blood Lead Model Results For the Resident Farmer Child

Receptor	Geometric Mean of Blood Lead Level (µg/dL)	Percent >10 µg/dL
Resident-Farmer Child	0.2-0.4	<0.0001
Benchmark[1]	5 (CDC Reference Blood Lead Level) 10 (USEPA Benchmark Blood Lead Level)	

[1] If receptor modeled lead levels are less than the CDC (5 µg/dL) and USEPA (10 µg/dL) blood lead level benchmarks, then modeled blood lead levels are considered acceptable and require no further evaluation.

CDC = Center for Disease Control.

HI = hazard index.

µg/dL = micrograms per deciliter.

Based on the cancer risk estimates, noncancer and target organ analysis HIs, and the separate evaluation for blood lead in children, there were no unacceptable human health risks identified for the baseline risk case. Because all baseline human health risks were considered acceptable, negligible impact on human health was identified in the vicinity of the proposed KMC.

3.16.4.2.3 Uncertainty Analysis

In general, conservative assumptions are made throughout the risk assessment to ensure that the health of local residents is protected. For the chemicals assessed, when all of the assumptions are combined, it is more likely that actual risks are overestimated rather than underestimated.

The assumptions that introduce the greatest amount of uncertainty in the proposed KMC Baseline Risk are discussed in this section. They are discussed in general terms and assigned a qualitative designation of low, medium or high uncertainty as to whether the assumptions overestimate or underestimate potential risk. Additional discussion of all uncertainties associated with the proposed KMC

HHRA is presented in the proposed KMC Baseline HHRA (Flatirons Toxicology, Inc. 2015). The most significant uncertainties associated with the proposed KMC HHRA Baseline Risk case are related use of 95 percent upper confidence limits as exposure point concentrations instead of individual residential area soil concentrations and the use of beef as surrogate for mutton consumption. Use of the 95 percent upper confidence limit for the proposed KMC residential areas provides reasonably conservative estimates for exposure point concentrations in all but a handful of residential areas that either have a chemicals of potential concern risk driver (a chemical responsible for most or all reported risk) at the highest concentration or a combination of risk driver chemicals of potential concern at elevated concentrations relative to their 95 percent upper confidence limit concentrations. Preliminary risk calculations revealed that variation in types of chemicals of potential concern and chemicals of potential concern concentrations across the residential sites were limited and that a single exposure point concentration for each chemical of potential concern could be used to estimate potential health risks for the site. The potential underestimate of risks from use of the 95 percent upper confidence limit is low (15 to 30 percent) and limited to only a handful of residential areas. Furthermore, the 95 percent upper confidence limit approach is more consistent with USEPA guidance and does not change overall results or conclusions for the proposed KMC Baseline HHRA in any significant way.

Conversely, the inclusion of essential nutrient metals and metals commonly used as therapeutic agents likely resulted in overestimates of potential noncancer health effects. For example, iron accounted for the highest portion of the Baseline HIs, but iron is an essential nutrient that is expected to be nontoxic at the intake levels estimated for proposed KMC residents. This factor had a high probability of overestimating the potential Baseline noncancer HIs by 30 to 50 percent.

Another potential source of uncertainty for the Baseline Risk case was the use of homegrown beef was used as a surrogate for the resident farmer livestock ingestion instead of lamb, even though lamb or mutton may be a preferred meat source for some area residents. This decision was based on the availability of beef biotransfer factors for the risk-driving metals at proposed KMC; lamb biotransfer factors for metals are not available. The use of beef as a surrogate for lamb was intended to capture exposures to a larger array of metals from the livestock ingestion pathway and presents a low to medium level of uncertainty in the HHRA. It is difficult to determine if the use of beef as a surrogate for home-raised meat overestimates or underestimates the potential risk for the livestock ingestion pathway; however, it can be concluded that risks for the resident farmer exposure scenario would be lower by up to a third or more, if the livestock ingestion pathway was not evaluated in the proposed KMC HHRA (Flatirons Toxicology, Inc. 2015).

3.16.4.3 Transmission Systems and Communications Sites

The existing transmission lines and communication sites operate at remote locations from NGS and proposed KMC. The communication sites include propane-fired backup generators that provide backup emergency power. Many of the sites are operated and maintained by other users. Given the relatively infrequent testing that is applied to these facilities, the remote locations, and the relatively low emission rates associated with propane-fired units, the air quality emissions and historical operation’s impacts on existing air quality conditions and soil deposition are assumed to be minimal. Maintenance activities for the communication sites, transmission lines, and access roads can include vehicle traffic (vehicle exhaust and fugitive dust from unpaved roads), but the maintenance activities are often infrequent, short duration, and/or localized. For example, transmission line structure maintenance and repair occur on an as-needed basis, routine actions such Southern Transmission System (STS) vegetation clearing occurs once every five years or more infrequently depending on need, repair of STS access roads and Western Transmission System (WTS) and STS transmission tower infrastructure occurs along localized sections of the lines or roads, and annual maintenance of WTS access roads occurs once or twice a year but equipment moves through the areas quickly. Therefore, emissions of historical operations are considered minimal, and because these impacts are infrequent, short duration, and localized, and thus cause very little effect, the environmental impacts are considered negligible. A HHRA was not performed for receptors located at these sites because the exposure and potential risk would be less than the exposure and potential risk for residential receptors located in the vicinity of NGS and proposed KMC.

3.16.4.4 Public Health

This section evaluates the current health conditions of the potentially affected community, the affected environment with respect to particulates, and demographics with respect to economy, land use, and baseline community health issues relevant to particulate inhalation.

3.16.4.4.1 Demographics – Land Use

This section provides information on current land use patterns and demographics particularly relevant to health. The local community includes members of the Navajo Nation and the Hopi Reservation within northern Coconino and Navajo counties, Arizona, particularly the Navajo Mountain Chapter (of the Western Agency) and portions of the Hopi Reservation surrounding NGS and the Kayenta Chapter (of the Western Agency) surrounding the proposed KMC, as well as the nearby off-reservation communities in the two counties, including Page, Arizona (**Figure 3.16-3**).

Detailed information on land use in the vicinity of the NGS and the proposed KMC is provided in Section 3.14, Land Use. As described in Section 3.14, the primary land use in the study area is livestock grazing by the Navajo (PWCC 2012 et seq.). The majority of the area is sparsely populated with dispersed residential dwellings or small communities. Commercial uses include small stores and gas stations located along major transportation routes and in or adjacent to local communities.

The NGS site is located in Coconino County approximately 3 miles east of Page, Arizona, within the LeChee Chapter of the Navajo Nation. Overall the area surrounding the NGS is sparsely populated with the exception of the City of Page which had a population of 7,247 in 2013 (City-data 2015). The developable area of LeChee is about 10 miles south of Page. Livestock grazing is an important land use for the LeChee Community. In addition, the residents of the LeChee Community enjoy dispersed recreation in the canyon areas where they hike and hunt. Other recreation in the vicinity of the NGS involves the large number of visitors to Lake Powell, Glen Canyon, the Antelope Canyon Tribal Park, and the Grand Canyon. The tourism industry is a large contributor to the economy of the City of Page.

The proposed KMC is located approximately 15 miles south of Kayenta, Arizona, in Navajo County on the Hopi Reservation and the Navajo Nation Chapters of Chilchinbito, Forest Lake, Kayenta, and Shonto. As detailed in Section 3.14, approximately 150 Navajo residents live in dispersed houses within the Kayenta permit boundary (Office of Surface Mining Reclamation and Enforcement [OSMRE] 2011, 2008). Frequently, multiple families will reside in a single dwelling. Many graze livestock (mainly cattle, sheep, and goats) on reclaimed lands for a food source and for economic and cultural reasons. Livestock grazing is the primary pre-mine use of the land and occurs year-round.

Other uses of the land by residents living within the permit boundary include the gathering of plants for food, medicine, cultural purposes, firewood gathering, and farming small agricultural plots (approximately 4 to 5 acres in size) typically used for growing corn (PWCC 2012 et seq.). As the mine areas are developed, residents occasionally need to be relocated to different areas.

Recreation activities in the vicinity of the proposed KMC consist primarily of dispersed recreation on Black Mesa, which is a prominent geographic feature of the Colorado Plateau. Typical activities include hiking, small game hunting, bird watching, and photography. No developed recreation is present in this area.

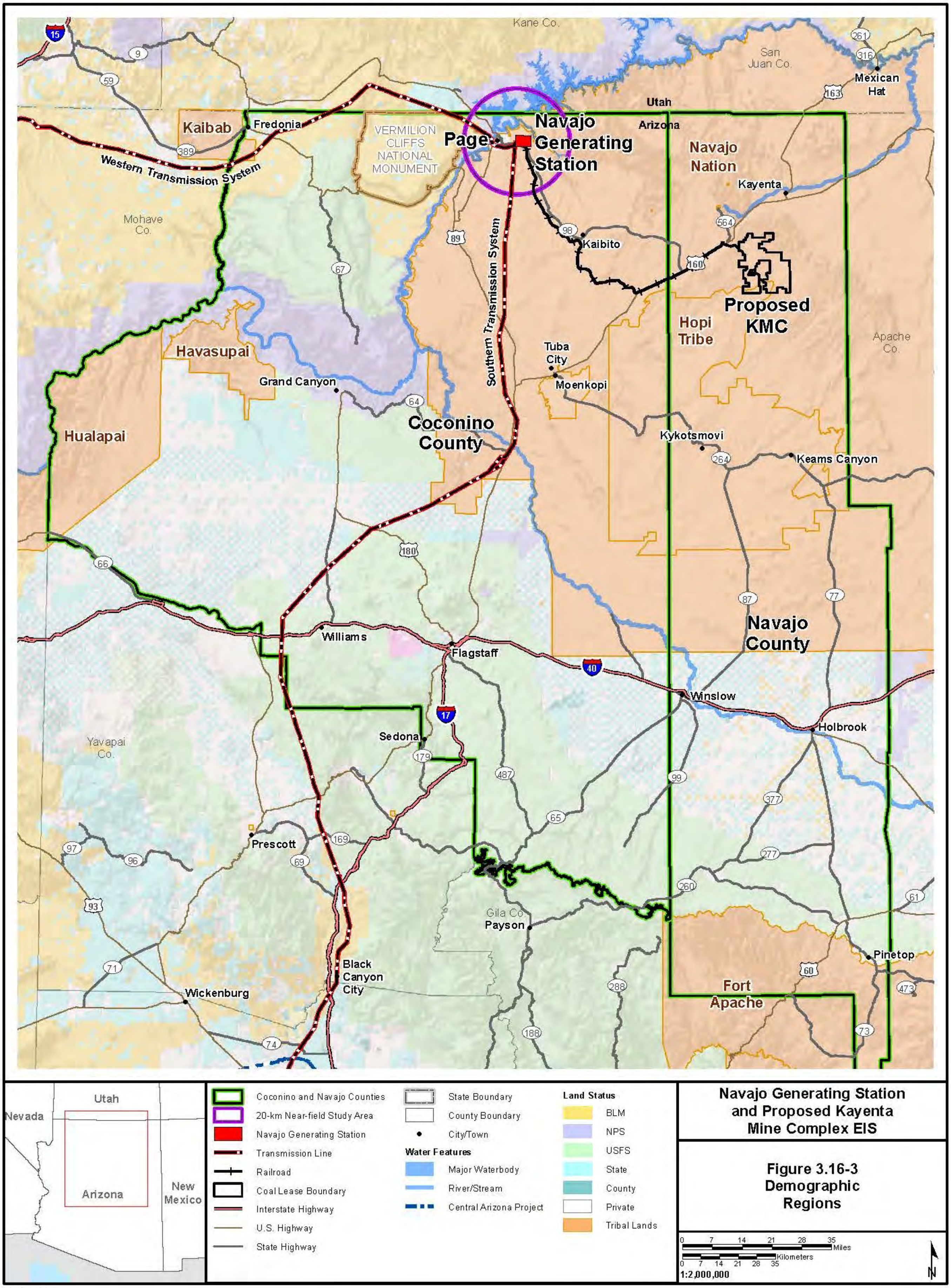

Figure 3.16-3
Demographic Regions

7/19/2016

3.16.4.4.2 Demographics – Population

Detailed population and demographic information is presented in Section 3.18. American Indians, primarily Navajo, were the single largest racial group in northeastern Arizona in 2010. Navajo accounted for over 90 percent of the population of the primary analysis area. Whites and individuals of other races accounted for less than four percent of the residents of the Hopi Reservation and portion of the Navajo Nation in Arizona. The majority of residents of Page were non-American Indian, although American Indians accounted for nearly 38 percent of the city's residents. Across the state and nation, American Indians comprised 5.5 percent and 1.7 percent of the population, respectively. The concentration of residents of other races and who are Hispanic or Latino are substantially higher across the state and nation than in the northeastern Arizona and the primary analysis area.

3.16.4.4.3 Economy

Detailed information on labor market conditions and other economic characteristics in the primary analysis area is provided in Section 3.18. In Navajo County, average incomes are lower among residents and poverty rates are higher than the state average (Navajo Public Health Services District 2012; U.S. Census Bureau 2015). In addition, unemployment rates of Navajo County also exceeded the State of Arizona unemployment rates. As discussed in Section 3.18, the general economic climate of the Navajo Nation and Hopi Reservation is poor and labor force participation on the Navajo Nation and Hopi Reservation is low in comparison to the statewide and off-reservation areas. Unemployment is persistently high among those in the labor force. The 2009 – 2013 American Community Survey estimated unemployment on the Navajo Nation at 21.6 percent, 4.7 percent points higher than on the Hopi Reservation, and 11.2 percentage points higher than the statewide average. Local estimates of unemployment are much higher (e.g., above 50 percent) on the Navajo Nation (Navajo Housing Authority 2011).

High unemployment, low labor force participation, and factors such as reliance on seasonal and part-time employment are manifested in household incomes that are below the statewide and national norms in terms of income distribution, higher than average dependency on public assistance, and poverty rates more than double the statewide rate. In 2010, an estimated 35 percent of Hopi and 38 percent of Navajo residents on the reservations had incomes below the poverty level (**Table 3.18-10**).

In the City of Kayenta, the median household income is substantially below the state median household income ($26,199 less), and the percent of people in poverty exceeds the state level by more than 33 percent (U.S. Bureau Census 2015). Kayenta also has a high unemployment rate of 9.4 percent, compared to the unemployment rate of the State of Arizona at 6.2 percent (Home Facts 2016). In contrast, Coconino County average incomes and unemployment rates are equal to the state average although, prior to 2013, Coconino County unemployment rates were consistently below the state level and median incomes were slightly higher than the state median (Coconino County Public Health Services District 2013). The median household income City of Page is above the state median, and poverty levels are slightly below the state level (U.S. Census Bureau 2015).

3.16.4.4.4 Community Health – Particulate Inhalation

This section describes the health status of the local community with a focus on health issues relevant to particulate inhalation, the most significant exposure pathway. Most general community health data in the vicinity of the study area is available at the county level. Limited additional information is available for Navajo peoples (Navajo alone or Navajo in combination[2]) living within the Navajo Nation or in Navajo Nation border towns, including Page, Arizona (Navajo Epidemiology Center-Navajo Department of

[2] As defined in NEC-NDOH (2013), the *Navajo alone* consist of individuals who claim to be only Navajo as their race during the 2010 U.S. Census. The *Navajo in combination* include individuals who claim to be Navajo only or individuals who claim to be *Navajo in combination* with another race or tribe.

Health [NEC-NDOH] 2013). As discussed in Gradient (2016), the NEC-NDOH has recently undertaken a multi-year disease surveillance project funded by the Centers for Disease Control and Prevention (CDC) to address the gaps in Navajo Nation specific health data. They are administering a Navajo Behavioral Risk Factor Surveillance Survey (BRFSS) to representative study populations across the Navajo Nation (NEC-NDOH 2014). The results of the Navajo BRFSS will provide baseline and ongoing disease surveillance within the Navajo Nation and will allow evaluations of disease rates within and across the Navajo Nation in ways that previously have not been possible using traditional epidemiological methods. The data collection timeline for the Navajo BRFSS includes three phases, and the survey will be administered to study populations within each of the five agencies, in turn (NEC-NDOH 2014). Data collection for the first phase was conducted in the Chinle Agency and completed in 2013; the final results for the Chinle Agency are available (NEC-NDOH 2015), and relevant findings are incorporated below in the discussion of specific Navajo health conditions.

At the county level, of the 15 counties in Arizona, Navajo County ranks among the unhealthiest in the state as summarized in the **Table 3.16-6** (larger numbers indicate worse health performance). Life expectancy rates are lower, mortality rates are higher, and many behavioral risk factor rates exceed the state averages. The socioeconomic patterns in Navajo County could be responsible for a large part of the discrepancy between the health patterns of Navajo County relative to the rest of Arizona. Navajo County has higher poverty rates, higher unemployment rates, and lower education averages. Behavioral risk factors that contribute to poor community health, such as smoking, obesity, poor diet, and lack of adequate physical activity are more common among communities with lower socioeconomic status, and this association is demonstrated in Navajo County (University of Wisconsin Population Health Institute 2015). The obesity and inactivity rates are higher in Navajo County compared to Arizona as a whole. These behavioral risk factors lead to increases in the prevalence of chronic diseases, such as cardiovascular diseases, stroke, and diabetes, which are among the leading causes of mortality in Navajo County.

Table 3.16-6 Coconino and Navajo Counties Health Ranking within Arizona

County	Coconino					Navajo				
Measure	2010 Report Rank (out of 15)	2012 Report Rank (out of 15)	2013 Report Rank (out of 15)	2014 Report Rank (out of 15)	2015 Report Rank (out of 15)	2010 Report Rank (out of 15)	2012 Report Rank (out of 15)	2013 Report Rank (out of 15)	2014 Report Rank (out of 15)	2015 Report Rank (out of 15)
Health Outcomes (mortality and morbidity)	5	4	5	5	6	14	12	12	12	12
Health Factors (overall)	3	3	4	4	4	11	13	13	12	13
Clinical Care (Uninsured adults, primary care providers rate, preventable hospital stays, diabetic screenings)	4	6	7	6	5	7	10	9	11	10

Table 3.16-6 Coconino and Navajo Counties Health Ranking within Arizona

County	Coconino					Navajo				
Measure	**2010 Report Rank (out of 15)**	**2012 Report Rank (out of 15)**	**2013 Report Rank (out of 15)**	**2014 Report Rank (out of 15)**	**2015 Report Rank (out of 15)**	**2010 Report Rank (out of 15)**	**2012 Report Rank (out of 15)**	**2013 Report Rank (out of 15)**	**2014 Report Rank (out of 15)**	**2015 Report Rank (out of 15)**
Health Behaviors (tobacco, diet and exercise, alcohol use, high risk sexual behavior)	2	1	1	1	1	9	10	10	10	9
Social and Economic Factors (education, employment, income, family and social support, community safety)	2	4	3	7	5	13	13	14	14	14
Physical Environment (air quality, built environment)	9	5	2	7	9	3	9	9	8	3

Source: County Health Rankings for Arizona (University of Wisconsin Population Health Institute 2015, 2014, 2013, 2012, 2011, 2010).

In contrast to Navajo County, Coconino County ranks among the healthiest in the state as summarized in **Table 3.16-6**. Many of the behavioral risk factors for Coconino County are ranked better than the State of Arizona (University of Wisconsin Population Health Institute 2015).

Rankings from the last 5 years have been fairly consistent for both counties, with the exception of rankings for physical environment, including air quality. The ranking for Navajo County in regard to physical environment have decreased (improved) and those for Coconino County have increased (declined). However, the air quality (specifically particulate matter with an aerodynamic diameter of 2.5 microns or less [$PM_{2.5}$]) was not the factor in the change. The change in the rankings was due mainly to drinking water standard violations and to driving alone, especially during long commutes.

The leading causes of death in Navajo and Coconino counties are summarized in **Table 3.16-7**. Most of the leading causes of death are related to chronic diseases that potentially could be mitigated by healthier lifestyles. Increased physical activity, improved diet, and the cessation of smoking could improve the county rates of obesity and high blood pressure, conditions which lead to some of the chronic diseases listed in **Table 3.16-7**. Some chronic diseases such as cardiovascular disease, chronic lower respiratory disease, and stroke are all potentially associated with particulate inhalation, particularly particulate matter with an aerodynamic diameter of 2.5 microns or less ($PM_{2.5}$) (see subsection *Health Effects of $PM_{2.5}$* for further discussion).

Table 3.16-7 Leading Causes of Death in Coconino and Navajo Counties

Cause of Death	Coconino County (rate per 100,000)	Navajo County (rate per 100,000)	Arizona State (rate per 100,000)
Major Cardiovascular Diseases (excluding stroke)	105.4	197.8	208.9
Cancer	101	169.3	170.1
Chronic Lower Respiratory Diseases	23.6	35.9	50.1
Accidents	68.5	100.3	47.7
Alzheimer's	13.3	17.5	36.2
Stroke	11.1	39.6	31.1
Diabetes	16.7	45.1	26.5
Suicide	19.2	22.1	17.0
Liver Disease and Cirrhosis	16.2	40.5	15.8
Influenza and Pneumonia	8.8	19.3	11.0

Source: Arizona Department of Health Services (ADHS) 2013.

As listed in **Table 3.16-7**, accidents or unintentional injuries are a large cause of mortality in Navajo County, with accident-related death rates for Navajo County (rate of 100.3 per 100.000) almost double those for Arizona (rate of 47.7 per 100,000). Accidental deaths are those that could be caused by motor vehicle crashes, poisoning, falls, and drowning (ADHS 2013). ADHS (2013) also presents the top 5 leading causes of death among American Indians of Arizona. The leading causes of death among Arizona American Indians (age-adjusted males and females, combined) are as follows: cardiovascular diseases (123 per 100,000); cancer (118 per 100,000); unintentional injury (104 per 100,000); diabetes (65.7 per 100,000) and liver disease and cirrhosis (62 per 100,000). Accidental injuries are the second leading cause of death among male Arizona American Indians, and the leading cause of death for American Indians ages 1 to 44 years (ADHS 2013).

As discussed in Gradient (2016), two reports published by ADHS provide perspective on the health of all Native Americans residing in the state, including Navajo and Hopi residents as well as those of other tribes (ADHS 2015a,b). These reports include observations that mortality rates of Native Americans in Arizona are elevated, relative to other state residents, for alcohol-induced causes, car accidents, diabetes, and unintentional injuries/accidents. Conversely, mortality rates of Native Americans in Arizona are lower on average than those for other state residents for lung cancer, chronic lower respiratory diseases, and heart disease.

According to the Navajo Population Profile (NEC-NDOH 2013), Navajo people are burdened with many health issues such as alcoholism, diabetes, and cancer. From an epidemiological standpoint, most of the current health issues affecting the Navajo people are related to socioeconomic status and social behavior. The Navajo Population Profile (NEC-NDOH 2013) also found that there are more women than men in the Navajo population overall. As the years progress, the higher percentage of women relative to men in the population profile increases. The Profile (NEC-NDOH 2013) indicates that a possible explanation is that males in this age range have a higher mortality rate due to alcoholism, injury, or other preventable diseases.

The Navajo Nation Mortality Report 2006-2009 (Navajo Epidemiology Center no date) reported unintentional injuries as the leading cause of death for Navajo Nation males and females from 2006-2009, accounting for 18.9 percent of all deaths (no age range is provided in the Navajo Nation Mortality Report 2006-2009). Among males, the mortality rate for unintentional injuries is 24.2 percent, nearly twice that of the next leading cause of death (heart disease, 12.5 percent) and accounts for nearly 1 in

4 male deaths. In contrast, unintentional injuries are the fifth leading cause of death in the U.S., and account for only 4.8 percent of all deaths. The age-adjusted mortality rate for unintentional injuries is 126.5 per 100,000 for the Navajo Nation and 37.3 per 100,000 for the U.S. in 2009. Death due to chronic liver disease and cirrhosis is the fifth leading cause of death for the Navajo Nation, accounting for 5.6 percent of all deaths, whereas chronic liver disease and cirrhosis is the twelfth leading cause of death for the U.S. accounting for 1.3 percent of all deaths. The age-adjusted mortality rates for chronic liver disease and cirrhosis are 43.1 per 100,000 and 9.2 per 100,000 for the Navajo Nation and U.S., respectively. **Table 3.16-8** summarizes the leading causes of death among the Navajo Population. Unintentional injuries account for nearly 1 in every 5 Navajo deaths. As reported in Navajo Nation Mortality Report 2006-2009, there are nearly 33 percent and 35 percent more unintentional injury deaths than cancer deaths and heart disease deaths, respectively.

Table 3.16-8 Leading Causes of Death Among Navajo

Rank	Cause of Death[1]	Rate per 100,000	Percent of All Deaths
1	Unintentional Injuries	107.73	18.9
2	Cancer	72.49	12.7
3	Heart Disease	69.48	12.2
4	Diabetes	32.66	5.7
5	Chronic Liver Disease and Cirrhosis	32.09	5.6
6	Influenza and Pneumonia	25.93	4.6
7	Suicide	17.05	3.0
8	Stroke	15.33	2.7
9	Septicemia	12.89	2.3
10	Dementia	12.03	2.1
11	Assault	11.89	2.1
12	Alcohol Dependence Syndrome	11.6	2.0
13	Renal Failure	11.03	1.9
14	Hypertensive Disease	8.45	1.5
15	Chronic Obstructive Pulmonary Disease	7.02	1.2

[1] Data includes both males and females.

Source: Navajo Nation Mortality Report 2006-2009.

Among the Navajo living in the Chinle Agency, a smaller percentage of the population considers that they are in excellent or very good health and a larger percentage considers that they are in fair health compared to the State of Arizona or the U.S. (NEC-NDOH 2013), as summarized in **Table 3.16-9** below. Forty-seven percent of Chinle Agency respondents were classified as obese (by body mass index) compared to 28.9 and 26.8 percent of U.S. and Arizona respondents, respectively. Twenty-seven percent of Chinle Agency respondents indicated that there was a time in the last 12 months when they felt they should see a doctor, but did not. By far the most common reason (34.7 percent) given for not seeing a doctor was an inability to get a ride to the medical facility.

Table 3.16-9 General Health Status Among Chinle Agency, U.S., and Arizona Populations

"Would you say that in general your health is…?"	Response (Age Adjusted Percent)		
	Chinle	U.S.	Arizona
Excellent	13.3	18.6	19.8
Very Good	14.6	33.5	33.0
Good	38.5	30.9	30.5
Fair	29.3	12.5	12.3
Poor	4.3	4.4	4.4

Source: 2013 Navajo Nation Health Survey, Chinle Agency Results (NEC-NDOH 2013).

The Navajo Area Indian Health Service is responsible for the delivery of health services to American Indians in portions of Arizona, New Mexico, and Utah (within a region known as the Four Corners area). The Navajo Area Indian Health Service is primarily responsible for healthcare to members of the Navajo Nation, but care also is provided to other Native Americans including the Hopi Tribe. As discussed in Gradient (2016), the Indian Health Service interactive national map of health facilities identifies healthcare facilities serving the Navajo Nation and Hopi Tribe (U.S. Department of Health and Human Services 2015) and indicates that 1 hospital is present on the Hopi Indian reservation, and 18 health centers, 7 health stations, and 7 hospitals are present within the boundaries of the Navajo Nation. None of these are located within 50 km of the NGS site. There is one hospital located in Page, Arizona, a few miles from the NGS site. Three hospitals and one health center in the Navajo Nation are located within 50 km of the proposed KMC site. One hospital is located in the vicinity of the Black Mesa/Lake Powell Railroad line.

In addition to the western healthcare services offered by the Indian Health Service, Navajo people often seek care from native healers or "medicine people." According to the Chinle Agency results from the 2013 Navajo BRFSS described above, 68.3 percent of Navajo residents in the Chinle Agency visited a native healer or used traditional medicine in the 12-month period prior to the survey (NEC-NDOH 2013).

3.16.4.4.5 Community Health – Diseases

The following sections specifically address current health status in the community for heart disease and stroke, diabetes, asthma, and lung cancer. This discussion compares the incidence of cardiovascular problems, respiratory problems, and lung cancer currently present in the local community as compared to other places in Arizona and the U.S. as a whole. Therefore, this discussion is not a measure of absolute health, but is a measure of whether, for the diseases reviewed, there is a different health pattern in the local community than in the rest of Arizona or the U.S.

3.16.4.4.5.1 Heart Disease and Stroke

The prevalence of heart disease and stroke in Navajo County is higher compared to Coconino County. Approximately 7.2 percent of adults in Navajo County were reported to have suffered a heart attack, which is almost double the 3.6 percent reported for Coconino County; compared to 4.8 percent in Arizona state and 4.4 percent in the Nation (ADHS 2012). Heart disease is the second leading cause of death in Arizona and the leading cause of death in Navajo and Coconino County. Mortality rates in Navajo County for cardiovascular disease (197.8 per 100,000) were almost double the mortality rates for Coconino County (105.4 per 100,000), however they also were slightly lower than Arizona (208.9 per 100,000) (ADHS 2013). Mortality rates among Navajo peoples for cardiovascular disease are significantly lower (69.48 per 100,000) (Navajo Nation Mortality Report, 2006-2009). Heart disease is the second leading cause of death in Arizona, the leading cause of death in Navajo and Coconino County, and the third leading cause of death among Navajo peoples.

Stroke is the sixth leading cause of death in Arizona and the fifth in the nation. In Navajo County, 4.5 percent of adults have had a stroke, compared to 1.1 percent in Coconino County and 2.9 percent for both Arizona and the Nation (ADHS 2012).[3] Stroke mortality rates among the Navajo peoples (15.3 per 100,000) and in Navajo County (39.6 per 100,000) were considerably higher than stroke mortality rates for Coconino County (11.1 per 100,000) and slightly higher than Arizona (31.1 per 100,000) (ADHS 2013; Navajo Nation Mortality Report 2006-2009).

3.16.4.4.5.2 Diabetes

The 2013 nationwide mortality data and the 2013 Arizona mortality data shows diabetes as the seventh leading cause of death for both the nation and the state (ADHS 2013; CDC 2014). The Navajo Nation Mortality Report, 2006-2009, shows diabetes as the fourth leading cause of death among the Navajo Nation. According to the Arizona Diabetes Burden Report, the age adjusted percentage of adults with diabetes in Arizona has steadily increased from 4.0 percent in 1995 to 8.1 percent in 2010 (ADHS 2011). American Indians in Arizona also were the population of race that had the highest reported percentage of diabetes at 15.8 percent. Diabetes also was found to be more prevalent in populations with lower incomes. Navajo County was reported as having a higher percentage of people diagnosed with diabetes at 15.4 percent when compared to Coconino at 11.7 percent. Both counties were higher than the state and national percentages of 10.6 and 10.2 (ADHS 2012).

3.16.4.4.5.3 Asthma

Limited relevant information was found for assessing asthma prevalence and severity among Navajo Nation or Hopi Tribe members. Arizona State's asthma rates are similar to the national rates. The 2012 Behavior Risk Factor Surveillance Survey showed that 13.5 percent of Arizona adults had asthma compared to 13.2 percent nationally (ADHS 2012). Navajo County has among the highest asthma rates in the state, with an adult rate of 17.2 percent. Coconino County asthma rates are slightly lower than the state and national rates at 12.1 percent. Since 2003, asthma rates in Arizona and the nation have steadily but slowly increased until 2010, at which point asthma rates began to slightly decrease (ADHS 2012).

In Arizona, the prevalence of asthma is higher among lower income populations. Adults with an annual household income less than $25,000 were reported to have higher percentages of asthma than adults with higher income brackets. "Other" (races not named), whites, and Hispanics have the highest percentages of asthma diagnosed. Nationally, black populations have higher asthma rates than whites. The Coordinated Federal Action Plan to Reduce Racial and Ethnic Disparities showed that minority children and children from impoverished families are disproportionately affected by asthma (U.S. President's Task Force 2012). According to the Arizona Comprehensive Asthma Control Plan, there was no statewide survey to accurately determine the number of children in Arizona with asthma. However, using the nationwide survey which utilized U.S. Census data, it was estimated in 2003 that the prevalence rates for pediatric asthma was 2.87 percent of the population for Navajo County and 2.38 for Coconino County (ADHS 2005).

3.16.4.4.5.4 Lung Cancer

Lung cancer is the leading cause of cancer deaths in both Arizona and the nation. In Arizona, lung cancer mortality rates increased from 1980 until 1999, when the trend reversed, and lung cancer mortality rates have declined through 2013. However, lung cancer was the number one cause of cancer

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[3] Self-reported lifetime prevalence – Survey respondent answered "yes" to "have you ever been told by a health care professional that you have coronary heart disease (or heart attack, angina, stroke, etc.)."

deaths from 2007 to 2011 in Arizona. In contrast to diabetes, American Indians have the lowest rate of lung cancer in Arizona (ADHS 2013). In 2014, the age-adjusted mortality rate of lung cancer was 42 per 100,000 people in Arizona (ADHS 2013). In Navajo County, the mortality rate (38.6 per 100,000) was slightly lower than the State rate, but in Coconino County the mortality rate (22.1 per 100,000) was considerably lower than the state rate. Air pollution also has been implicated in the development of some lung cancers, but this association is still under study. The USEPA concluded in the 2009 particulate matter evaluation that particle pollution may cause lung cancer (USEPA 2009b).

NEC-NDOH (2010) summarizes the incidence and mortality rates for various types of cancer among the Navajo Nation. Overall, the report indicated a lower or comparable incidence of most cancer types in the Navajo population relative to that in Arizona/New Mexico and the U.S. as a whole. Information from the ADHS (2013) online database also indicated that, based on data from 2005-2009, the incidence of all cancer types in the Navajo Nation was significantly lower than statewide. The reported incidence in the Hopi Tribe was more than twice that for the Navajo Nation, but was only approximately 15 percent greater than incidence in Arizona overall and not statistically significant: 478 per 100,000 (95 percent CI: 395-560). As summarized in Table 3.1, information from the Arizona Health Matters website (Healthy Communities Institute 2015) indicates that the 2012 incidence of all cancers combined in Coconino and Navajo counties was approximately 75 percent of the national incidence rate, while the county incidence rates for lung and bronchus cancer were approximately one-half of the national rates.

3.16.4.4.6 Environment – Air Quality

Section 3.1 provides a detailed assessment of the current air quality conditions in the study area. As described in Section 3.1, criteria air pollutants are monitored at a regional level and at several locations on and near the area of the Proposed Action. Section 3.1 provides a summary of 2011 to 2014 criteria air pollutant results compared to ambient standards for sites in northern Arizona, Southern Utah, extreme northwestern New Mexico (San Juan County), and southwestern Colorado for carbon dioxide monitoring. The data demonstrate that the regional air quality conditions are much better than the National Ambient Air Quality Standards (NAAQS) for all criteria pollutants. The overall air quality conditions and air quality related values in the region are generally improving or being maintained.

Section 3.1 also provides a summary of 2011 to 2014 monitored air quality conditions at the proposed KMC compared to ambient standards. The data demonstrate that the local air quality conditions near the area of the Proposed Action are better than the NAAQS for all criteria pollutants.

Gradient (2016) compares 2012-2014 averages of pollutant data for criteria pollutants for the Glen Canyon and proposed KMC ambient air monitors, with corresponding data for a number of cities in the U.S. Southwest and West – Denver, Las Vegas, Los Angeles, Phoenix, Salt Lake City, and San Diego. Gradient (2016) indicates that air quality in the vicinity of the NGS facility and within the proposed KMC facility is either similar to or better than that of many of the major population centers in the U.S. Southwest and West.

Gradient (2016) further compared the current air quality conditions in the study area to other U.S. locales, and reported that the World Health Organization (WHO) also indicate that Coconino and Navajo counties have good air quality relative to other U.S. and worldwide locales. With regard to $PM_{2.5}$ air quality, the American Lung Association (ALA) publication, “State of the Air 2015” (ALA 2015), ranked Coconino County as being among the cleanest in the country. For example, among the more than 600 counties in the U.S. with $PM_{2.5}$ monitors, Coconino County was ranked in the top 25 cleanest U.S. counties for “Year-round Particle Pollution (Annual $PM_{2.5}$).” In addition, having no days when $PM_{2.5}$ levels reached the unhealthful range based on USEPA's Air Quality Index, Coconino County was among the counties listed by ALA as the “Cleanest Counties [in the U.S.] for Short-term Particle Pollution (24-hour $PM_{2.5}$).”

As reported in Gradient (2016), the Flagstaff, Arizona, metropolitan statistical area in Coconino County was listed among the "Top 25 Cleanest U.S. Cities for Year-round Particle Pollution (Annual $PM_{2.5}$)," ranked Number 5, with a design value5 of 5.3 micrograms per cubic meter ($\mu g/m^3$). With an overall ranking of #1 based on 24-hour $PM_{2.5}$ concentrations, the Flagstaff, Arizona, metropolitan statistical area is listed among the "Cleanest U.S. Cities for Short-term Particle Pollution (24-hour $PM_{2.5}$)." Finally, Flagstaff is among just 17 U.S. cities ranked as being the top cleanest cities for both year-round and short-term particle pollution. Thus, the ALA assessment does not suggest that NGS emissions have detrimental effects on $PM_{2.5}$ air quality and instead supports Coconino County as being one of the cleanest U.S. counties in terms of particle pollution.

Overall, the analysis of recent air quality data for the criteria air pollutants indicate that NGS and proposed KMC emissions do not result in exceedance of the health-protective NAAQS levels at air quality monitors in or near the Navajo Nation. Concentrations of these criteria air pollutants are general in compliance with NAAQS at the air quality monitors closest to the NGS and proposed KMC facilities. In addition, historical monitoring data indicate that air quality in and near the Navajo Nation has generally been better than today's NAAQS levels.

The existing environment for air quality and deposition, as presented above, already is capturing the effect of the Proposed Action on a regional scale, except for proposed additional controls related to Selective Catalytic Reduction (SCR) installation at NGS or the potential shutdown or curtailment of a unit at NGS. Such changes would act to reduce the impact from current operations, and may lead to further reductions in impacts on air quality and air quality related values in the region.

The release of $PM_{2.5}$ to the air and its possible effects on the local population was selected for evaluation for the reasons described below. PM is a complex mixture of very small particles and liquid droplets. PM can be generated by numerous sources and can be made up of a number of components, including acids, organic chemicals, metals, and soil or dust particles (USEPA 2009b). PM may be emitted directly from a source (i.e., primary particles) or may form in reactions in the atmosphere (i.e., secondary particles). Sources of primary particles include construction sites, unpaved roads, power plants, motor vehicles, mining operations, and biomass combustion (e.g., forest fires and residential wood combustion). Components of secondary particles can originate from sources such as power plants, industries, and vehicle emissions (Stanek et al. 2011; USEPA 2009b).

Following inhalation, deposition and retention of particles in the respiratory tract is strongly dependent upon the size of the particles (Hinds 1999; USEPA 2009b), although other factors, such as particle shape and chemical composition, also play a role. In general, the larger the particle, the higher in the respiratory tract it will be deposited. Particle size is generally described using the aerodynamic diameter of individual particles. Larger particles (i.e., with aerodynamic diameters ≥ 20 μm) are subject to deposition in the nose and pharynx and removal by nose blowing. Very small particles, with aerodynamic diameters <10 μm and especially <2.5 μm, have greater potential to penetrate to the terminal bronchioles and the alveoli. Because of their ability to reach the deep lung, particles with aerodynamic diameters <10 μm are considered the most likely to cause health effects. USEPA regulates PM in two size fractions, PM_{10} and $PM_{2.5}$, and is considering establishing regulatory criteria for ultrafine particles ($PM_{0.1}$) as well.

USEPA's Integrated Science Assessment for Particulate Matter reviewed a large body of evidence for health effects associated with exposure to PM and established a weight-of-evidence framework for determining causality for certain health effects associated with relevant pollutant exposures (USEPA 2009b). USEPA identified five categories for characterizing available information regarding causality: 1) causal relationship; 2) likely to be a causal relationship; 3) suggestive of a causal relationship; 4) inadequate to infer a causal relationship; and 5) not likely to be a causal relationship. USEPA concluded the following for exposure to $PM_{2.5}$:

- A causal relationship between short-term and long-term exposure to $PM_{2.5}$ and cardiovascular effects has been demonstrated.
- There is likely to be a causal relationship between short-term and long-term exposure to $PM_{2.5}$ and respiratory effects.
- A causal relationship between short-term and long-term exposure to $PM_{2.5}$ and cardiovascular and respiratory mortality has been demonstrated.

In addition, PM exposures have been linked with worsening adverse effects in asthmatics. PM has been potentially linked ("suggestive" rating) with worsening existing cardiopulmonary problems for those with diabetes (USEPA 2009b). Until recently, particulate exposures have not been found to increase the incidence of asthma, only to worsening the condition under certain circumstances; however, some recent studies indicate there may be a causal link between particulate inhalation and an increased incidence of asthma (American Academy of Pediatrics 2004; Guarnieri and Balmes 2014; Patel and Miller 2009; USEPA 2009b). This is an ongoing area of research. In addition, there is evidence that asthmatics and other populations with compromised respiratory systems also may be more susceptible to viral and bacterial respiratory infections during and after increases in air pollution events (Kelly and Fussell 2011; USEPA 2009b).

It is important to note that there are multiple causes of the diseases associated with particulate exposures. Although it is possible that some cases of cardiovascular problems, respiratory problems, lung cancer, and diabetes may be related to or result from $PM_{2.5}$ or be worsened by $PM_{2.5}$ (primarily at air pollution levels that are substantially higher than those expected from the Proposed Action's minimal increase in particulate emissions), most cases of these health problems are associated with other causes, including those found at higher rates in Navajo and Coconino County (e.g., lifestyle factors such as diet, inactivity, and alcohol consumption).

Because the physical and chemical composition of PM is complex and can vary greatly, questions remain as to whether some PM types or specific components pose a greater human health hazard than others (Adams et al. 2015; Wyzga and Rohr 2015). Two specific types of PM associated with NGS-KMC operation, diesel exhaust emissions and coal dust emissions, are discussed in further detail. In addition, the burning of coal in homes, as commonly practiced by Navajo peoples, as a source of particulate matter via indoor air to the Navajo people also is discussed.

3.16.4.4.6.1 Diesel Exhaust Emissions

As described in Gradient (2016), diesel engine exhaust is a complex mixture of thousands of chemical constituents in vapor, gaseous, and particulate phases (International Agency for Research on Cancer 2014; USEPA 2002). Diesel engine exhaust is dominated by products of complete combustion, namely carbon dioxide and water vapor; however, owing to impurities in diesel fuel and conditions that prevent complete combustion, diesel engine exhaust also typically contains smaller amounts of PM (known as DPM or diesel exhaust particulate) and various gaseous substances. Increasingly more stringent emission standards and major advances in diesel engine technologies in the last couple of decades have resulted in dramatic reductions in DPM levels and changes in DPM composition.

Gradient (2016) reviewed the available body of literature relevant to health effects associated with exposure to DPM. Gradient (2016) indicates that a variety of health effects have been linked to elevated DPM exposures, including acute irritant effects (e.g., eye, throat, or bronchial irritation), respiratory symptoms (e.g., cough, phlegm, and wheezing), immunologic effects (e.g., exacerbation of asthma and allergenic responses), lung inflammatory effects, cardiovascular health responses (e.g., clotting or other blood flow restrictions), and cancer (e.g., lung cancer) (Gradient 2016). However, most of the health effects information for DPM exposures is associated with DPM produced through traditional diesel exhaust that is characteristic of older diesel engines. Gradient (2016) reports that although relatively few health effects studies have assessed new technology diesel exhaust (i.e., exhaust from post-2006, low emission, advanced-technology diesel engines), recent studies indicate that health risks posed by new technology diesel exhaust are less than those observed for traditional diesel exhaust, and recent findings indicate that new technology diesel exhaust is not carcinogenic.

3.16.4.4.6.2 Coal Dust Emissions

Coal dust consists of small fragments of coal that can be generated when coal is handled, stored, and transported. As with other particulate matter sources, coal dust is a complex mixture, with its toxicity depending on chemical composition and the size of the dust particles. Coal's chemical composition varies across the geographic regions from which it is mined; consequently, coal dust composition also varies. Chemical components potentially toxic to humans include silica, polycyclic aromatic hydrocarbon compounds, and trace metals, such as arsenic, lead, copper, iron, mercury, and selenium. Metals concentrations in coal dust are typically low. For example, the Montana Bureau of Mines and Geology recently analyzed coal samples from the Otter Creek coal bed in Montana and reported concentrations of various metal elements mostly in the range of a thousandth of a percentage or less by mass (U.S. Department of Transportation 2015). Metals and polycyclic aromatic hydrocarbon compounds are found in a similar concentration range in coal samples collected at the proposed KMC site (Ramboll Environ 2016b). As described above, the health risks of airborne PM depend strongly upon particle size, which determines how well particles penetrate and are retained in the respiratory tract, where they are deposited and/or transported, and where and to what extent they are absorbed. Thus, in addition to any chemical-specific toxicity, the size of individual dust particles also plays an important role in the toxic potential of coal dust. The particle sizes of coal dust emissions will vary depending on the source materials, the processes leading to the emissions, and the distance from the emission source. Based on information regarding the average sizes of uncontrolled particle emissions resulting from handling and processing of ores, like coal, it has been estimated that most coal dust emissions are likely to be generated during bulk coal handling and storage, and that typically approximately half of the particles would be in the PM_{10} size range, and only approximately 15 percent would be in the $PM_{2.5}$ size range (Ramboll Environ 2016b; USEPA 1995).

Furthermore, particle size and shape determines the potential for and extent of particle transport. As particle size increases, particles are less likely to be lifted into the air and, once airborne, are less likely to stay suspended. In general, the potential for coal dust exposure decreases with increasing distance from the emission source.

Relatively little toxicology and epidemiology research has been conducted to evaluate coal dust toxicity. Most research regarding the potential health effects of coal dust exposure has focused on occupational settings, specifically those of coal miners exposed to dust in above-surface or underground coal mines. Underground miners typically are exposed to very high concentrations of airborne coal dust for many hours per day over years of employment. As reported in Gradient (2016), these concentrations are orders of magnitude greater than the highest airborne dust concentrations that would be expected in non-occupational settings (National institute for Occupational Safety and Health 2011; Pless-Mulloli et al. 2001). Gradient (2016) explored, in depth, the available literature relating to toxicity associated with exposure to coal dust. Taken together, Gradient (2016) reported that the studies suggest that chronic exposure to coal dust at exposure levels as high as the federal permissible limit results in low overall toxicity.

3.16.4.4.6.3 Indoor Burning of Coal and Wood

An additional source of local Navajo PM exposure and health information (in relation to nearby coal mines) is a research study titled “Navajo Coal Combustion and Respiratory Health Near Shiprock (Bunnell et al. 2010). The U.S. Geological Survey-supported study addressed the issue of coal burning in homes as a source of particulate matter via indoor air to the Navajo people. Two power plants, Arizona Public Service Company Four Corners Power Plant and Public Service of New Mexico San Juan Generating Station, located near Shiprock, New Mexico together consume the second largest amount of coal in the nation. The coal mines, Navajo Mine Complex and San Juan Generating station that supply

Four Corners Power Plant and San Juan Generating Station, respectively, are located adjacent to the plants. The Navajo Mine Complex is leased from the Navajo Nation. Shiprock is considered unique on the reservation because atmospheric thermal inversions trap air pollution low to the ground, which tend to create a thick layer of smog most often during winter.

Significant amounts of coal are still used for home heating and cooking by the Navajo people. Though, a survey conducted during the mid-1990s reported that coal is used primarily for heating rather than for cooking in the Shiprock area (Los Alamos National Laboratory and Navajo Community College 1997). Compared to the general U.S. population, American Indians suffer disproportionately from respiratory morbidity. Based on the unique properties of Shiprock and published health studies (Morris et al. 1990; Robin et al.1996), the Shiprock study was performed to support the hypothesis that indoor air quality is a factor associated with respiratory illness among the Navajo.

Key factors that influence exposure potential associated with indoor wood and coal combustion include the type and condition of the stove and associated venting, whether the fuel is used for heating and/or cooking, and the type of coal:

- Emissions are higher for stoves that are not functioning properly and/or are not properly vented. In studies of the Shiprock area, stoves used for burning wood and coal were found to have a number of characteristics that would tend to increase emissions. Specifically, some stoves were homemade, at least 10 years old, not properly vented or not vented to a chimney, and/or vented to a chimney with visible cracks (Charley 2013; USEPA 2014).
- Both the duration and intensity of exposure differ depending on whether the fuel is used for cooking or heating. Although use of a specific fuel type for heating may be associated with a longer exposure duration, its use in cooking is associated with higher peak exposures, especially for women and children involved in cooking activities (who may be in closer proximity to the stove during such activities). A survey conducted during the mid-1990s reported that coal is used primarily for heating rather than for cooking in the Shiprock area (Los Alamos National Laboratory and Navajo Community College 1997).
- Different types of coal (e.g., bituminous vs. anthracite) may differ in composition. Whereas bituminous coal has a higher sulfur content, anthracite coal has a higher carbon content (Gordon et al. 2014). The coal available regionally in the vicinity of the Environmental Impact Statement study area is low-sulfur bituminous coal (Ramboll Environ 2016b).

The Shiprock study found that respiratory disease/conditions increased in the winter as compared to summer even though power plant emissions were greater in the summer months. The study also noted that the smoke from residential chimneys used for heating was a likely significant factor to the observed thick brown smog that indicates heavy air pollution. The Shiprock study quantified $PM_{2.5}$ levels and chemically characterized particulate matter inside homes of Navajo Nation residences. Many residents were exposed to $PM_{2.5}$ levels greater than the USEPA 24-hour standard for ambient air; most likely due to the combustion of wood and coal for home heating purposes. The research also found that one-quarter of the stoves used for coal combustion were not designed to operate at the higher temperatures required for burning coal. A comparison of both organic and trace elements indoors versus outdoors also suggested indoor coal use increased human exposure and may be a factor to Navajo respiratory health problems. The results of the Shiprock study suggests that respiratory disease/conditions risks could be reduced by changing methods of home heating such as upgrading or exchanging old stoves or opening controllable dampers in chimneys. Another factor that affected $PM_{2.5}$ levels in the study was the number of windows in a residence; better ventilated homes resulted in lower measurements of fine particulate concentrations.

Gradient (2016) includes a comprehensive compilation of the available data on the potential health impacts associated with indoor coal burning practices. The Shiprock study has provided data that wood and coal burning within a house may contribute to poor indoor air quality and therefore may be promoting respiratory health risks. However, additional studies directly linking indoor $PM_{2.5}$ concentrations and respiratory health outcomes in coal burning versus non-coal burning households are needed to resolve this issue conclusively.

Many American Indian residents living near the proposed KMC, including members of the Navajo Nation, use coal for heating homes. Coal used for home heating and cooking comes from many sources throughout the Navajo Nation. PWCC provides coal at no cost to Navajo tribal members living near the mine. Navajo tribal members living further away from the mine must pay for coal obtained from the mine. A pamphlet developed by PWCC describing safety tips for proper in-home use is available for residents who obtain coal from PWCC.

3.16.5 Environmental Consequences

3.16.5.1 Issues

The estimation of potential risks to human health receptors located in the study areas based on air emissions due to the Proposed Action and the impact of the Proposed Action on public health issues are evaluated in this section.

3.16.5.2 Assumptions and Impact Methodology

3.16.5.2.1 Human Health Risk Assessment

The analysis method for the HHRAs consist of the following:

- Identify the key chemicals of potential concern for the NGS and proposed KMC sites;
- Analyze the impact on exposure media by deriving exposure point concentrations for each medium;
- Evaluate the potential adverse health effects from chemicals of potential concern;
- Assess the potential cumulative impacts from the Proposed Action combined with past, present, and reasonably foreseeable projects; and
- Determine impact to human health receptors based on magnitude of cancer risk estimates and noncancer HIs, i.e., acceptable risk estimates are associated with negligible impact on human receptors.

3.16.5.2.2 Public Health

In assessing the potential for health impacts due to the Proposed Action, the health categories selected and described in the affected environment discussion in Section 3.16.4 are evaluated in this section. The magnitude of the health impact is assessed. In assessing the magnitude of the impact (high, medium, low, or none), several factors are evaluated: the level of consequence, the duration of the exposure, and the number of people potentially affected. In addition to categorizing the strength of the impacts, effects are categorized as positive or negative. Each impact category is defined on **Table 3.16-10**.

Table 3.16-10 Definitions of Health Impact Categories

Impact	Positive Effect	Negative Effect	Mitigation
None	No discernible or measurable impacts		None
Low	Low level quality-of-life impacts, low/short exposures, limited area/people affected	Low level quality of life impacts, low/short exposures, limited area/people affected	Mitigation measures possible
Medium	Significant quality-of-life enhancement, or reduce	Exacerbations of existing illness, reduction in quality of	Mitigation measures possible, but minor residual negative

Table 3.16-10 Definitions of Health Impact Categories

Impact	Positive Effect	Negative Effect	Mitigation
	exacerbation of existing illness, or reduce disease incidence; Moderate, intermittent, exposures, relatively localized	life (e.g., increase in "nuisance" factors such as noise/odors); Moderate, intermittent, exposures, relatively localized	effects may remain
High	Prevent deaths/prolong life	Increase deaths, increase chronic or acute diseases, increase mental ill health; High/long duration exposures, over a wide area	Mitigation measures possible, but residual negative effects may remain

Source: International Council on Mining and Metals (ICMM) 2010.

As described in ICMM (2010), when analyzing the overall public health impact, the magnitude of the consequence is combined with the likelihood that the consequence will occur. There is no universally agreed upon formula for assessing overall public health impact (ICMM 2010). Characterization of public health effects relies on qualitative and quantitative evidence (NRC 2011) and the assessments of the magnitude of the impact or likelihood of occurrence are often based on a subjective judgement (ICMM 2010). As recommended in NRC (2011) and ICMM (2010), a matrix can be a useful way to organize the results of the public health analysis and to convey results of the overall public health impacts in a manner that is easy to understand. The matrix is supplemented in the following sections with clear explanation of the evidence used to develop the ratings in each public health category. Overall impact rating on public health is assigned using the following matrix, which was adapted from ICMM (2010) and (NRC 2011). The characterization of the magnitude or consequence of action is determined by using the descriptions of public health impact categories provided in **Table 3.16-10**. The number of persons affected and the spatial impact is considered when determining the magnitude of action.

3.16.5.3 Proposed Action

3.16.5.3.1 Human Health Risk Assessment

3.16.5.3.1.1 Navajo Generating Station HHRA

Due to the various uncertainties described in Chapter 2.0, the future operation of NGS may range across a number of generation scenarios. A set of reasonably foreseeable future operation scenarios were modelled to capture the highest and lowest potential environmental impacts from air emissions.

The scenarios with the highest (3-Unit Operation) and lowest (2-Unit Operation) nitrogen oxides emissions were selected.

<u>Exposure to NGS 3-Unit Operation Emissions</u>

A HHRA evaluating potential human health impacts due to exposures to chemicals of potential concern emitted from the NGS at levels representing a total output of 2,250 MW between 2020 and 2044 (i.e., 3-Unit Operation HHRA) in the study area (within 50 kilometers [km] of NGS) is described in this section.

The chemicals of potential concern quantitatively evaluated in the 3-Unit Operation HHRA include metals, polychlorinated dibenzodioxins, polychlorinated dibenzofurans, polycyclic aromatic hydrocarbons, volatile organic compounds, DPM, diphenylmethyl, and some other inorganics. Cyanide was removed from the original NGS chemicals of potential concern list because it was not found in the emission inventory from the facility. Additional discussion on the removal of cyanide from the NGS chemicals of potential concern list is provided in the NGS HHRA (Ramboll Environ 2016a). Exposure point concentrations for chemicals of potential concern in air were based on model-predicted air concentrations provided by the near-field air modeling (Ramboll Environ 2016a). Exposure point concentrations for chemicals of potential concern in soil, surface water, sediment, homegrown produce, livestock, fish, and breast milk were estimated following methodology recommended in the HHRAP (USEPA 2005) based on air concentrations and deposition rates predicted by the near-field air modeling.

Emission modeling was conducted for years 2020 and 2030 representing pre-SCR and post-SCR conditions, respectively. The emissions for affected sources and chemicals of potential concern are different between pre-SCR and post-SCR conditions (Ramboll Environ 2016a). The HHRA conservatively uses the higher emissions in exposure point concentration estimation and risk characterization.

The near-field air dispersion and deposition modeling was used to assess the ambient air concentrations and deposition rates, which were then used to estimate media concentrations for chemicals of potential concern in the HHRA. In accordance with recommendations in the HHRAP guidance, AERMOD was used in this analysis. The modeled emission sources included the three 750-MW electric generating units and associate ancillary sources, fugitive dust sources (e.g., from ash disposal area), and on-road/off-road mobile sources at NGS. Buildings and other large structures also were incorporated in the model in case the plumes emitted from stacks were influenced by the aerodynamic wakes caused by nearby structures. The parameters used to characterize each emission source (e.g., stack height, air flow rates) and details of the modeling scenarios are described in the Near-field Dispersion and Deposition Modeling Protocol (Ramboll Environ 2016d).

Air concentrations for each chemical of potential concern were predicted by the near-field air modeling at each modeled receptor location. Chemicals of potential concern concentrations in soil, produce, livestock, and breast milk were estimated for each receptor location using HHRAP methodology based on near-field air modeling predicted air concentrations and deposition rates. Chemicals of potential concern concentrations in surface water, sediment, and fish tissue were not modeled for each receptor location within the waterbody because surface water is a dynamic system. Instead, the chemicals of potential concern concentrations were estimated to represent the whole waterbody based on the overall load calculated using average dispersion factors and deposition rates over the waterbody or the associated watershed following the recommended approach from HHRAP. The model-predicted exposure point concentrations for soil, surface water, and sediment used in the 3-Unit Operation HHRA generally are a few orders of magnitude lower than the field sampling data collected in the summer of 2014 for the baseline HHRA to evaluate the affected environment. It was concluded that the chemicals of potential concern concentrations detected near the vicinity of NGS likely are naturally occurring and the contribution from NGS is minimal.

NGS 3-Unit Operation HHRA Results

The 3-Unit Operation HHRA evaluated the human health impact from chemicals of potential concern solely emitted from NGS under the 3-Unit Operation (excluding baseline) in two zones within the NGS study area, the 0- to 20-km zone and the 20- to 50-km zone. There is a significant decreasing trend in near-field air modeling predicted air concentrations and deposition rates along the distance from NGS. Environmental medium concentrations predicted in the 0- to 20-km zone are much higher than those predicted in the 20- to 50-km zone; consequently, the human health impact within the 0- to 20-km zone was quantitatively evaluated. The human health impact within the 20- to 50-km zone was expected to be much lower than the 0- to 20-km zone and was therefore not quantitatively evaluated (Ramboll Environ 2016a).

As presented in **Table 3.16-11**, the results of the 3-Unit Operation HHRA predicted that the excess lifetime cancer risks due to emissions from NGS at a total output of 2,250 MW levels for each receptor evaluated in the HHRA were within the acceptable USEPA cancer risk range of 1 x 10^{-4} to 1 x 10^{-6}. For noncancer effects, the 3-Unit Operation HHRA reported all HIs less than the benchmark of 1. The estimated average daily doses for infants exposed to dioxins/furans through ingestion of breast milk were well below the national average background exposure level of 60 kilogram/day toxic equivalency quotient. As presented in **Table 3.16-12**, the estimated blood lead concentrations were well below both the USEPA target blood lead level of 10 µg/dL and the CDC reference blood lead level of 5 µg/dL. Given the degree of conservatism purposefully built into the risk assessment methods and benchmarks, the results of the 3-Unit Operation HHRA concluded that negligible impact on human health was identified in the vicinity of NGS based on this future scenario because potential risks to human health were considered acceptable, and required no further evaluation.

Exposure to NGS 2-Unit Operation Emissions

A HHRA evaluating potential human health impacts due to exposures to chemicals of potential concern emitted from the NGS at levels representing a total output of 1,500 MW between 2020 and 2044 (i.e., 2-Unit Operation) in the Near-field study area (within 50 km) of NGS is described in this section.

NGS 2-Unit Operation HHRA Results

Similarly to the 3-Unit Operation HHRA, the 2-Unit Operation HHRA quantitatively evaluated the potential human health impact from chemicals of potential concern solely emitted from NGS under the 2-Unit Operation within the 0- to 20-km zone. The human health impact from chemicals of potential concern within the 20- to 50-km zone was expected to be much lower than the 0- to 20-km zone and was therefore not quantitatively evaluated (Ramboll Environ 2016a).

As presented in **Table 3.16-11**, the results of the NGS 2-Unit Operation HHRA (1,500 MW) predicted that the excess lifetime cancer risks due to emissions from NGS at a total output of 1,500 MW levels at the location representing the maximally exposed individual were within the acceptable USEPA cancer risk range of 1×10^{-4} to 1×10^{-6}. For noncancer effects, the 2-Unit Operation HHRA) reported all HIs less than the benchmark of 1. The estimated average daily doses for infants exposed to dioxins/furans through ingestion of breast milk were well below the national average background exposure level of 60 kilogram/day toxic equivalency quotient. As presented in **Table 3.16-12**, the estimated blood lead concentrations were well below both the USEPA target blood lead level of 10 µg/dL and the CDC reference blood lead level of 5 µg/dL. Given the degree of conservatism purposefully built into the risk assessment methods and benchmarks, the results of the 2-Unit Operation HHRA concluded that negligible impact on human health was identified in the vicinity of NGS based on this future scenario because potential risks to human health were considered acceptable and required no further evaluation. The NGS baseline HHRA results are presented in **Table 3.16-11** and **Table 3.16-12** for comparison purposes. In general, the 3-Unit Operation and 2-Unit Operation HHRA results (cancer risk estimates, HIs, breast milk average daily doses, and estimated blood lead concentrations) were less than those for the baseline HHRA.

Additional risk scenarios included for evaluation as part of the Proposed Action include the potential human health impacts from proposed KMC emissions under the 8.1 million tpy scenario (the more conservative scenario between the two proposed KMC future operation scenarios) on the sensitive receptors located within the study area of NGS. This scenario was evaluated based on the proposed KMC air modeling results for the 8.1 million tpy scenario at the overlap area of NGS and proposed KMC air modeling domains and combined with the impacts of the NGS 3-Unit Operation HHRA results.

Table 3.16-11 Comparison of NGS Baseline and Proposed Action HHRA Results

Receptor	Cancer Risk			Hazard Index			Breast Milk Average Daily Dose (pg/kg-bw/day)		
	Baseline	3-Unit	2-Unit	Baseline	3-Unit	2-Unit	Baseline	3-Unit	2-Unit
Resident	2E-06	3E-06	2E-06	0.1	0.06	0.04	0.27	0.00024	0.00016
Resident-Gardener	5E-06	3E-06	2E-06	0.7	0.06	0.04	0.45	0.00046	0.0003
Resident-Farm Family	4E-05	4E-05	4E-05	0.8	0.2	0.2	1.9	0.0057	0.0038
Recreational User	4E-06	3E-08	3E-08	1.2[1]	0.01	0.01	NA	NA	NA
Commercial Worker	5E-07	9E-06	9E-06	0.02	0.05	0.04	NA	NA	NA
Benchmark[2]	1E-04 to 1E-06			1			60		

[1] The HI of 1.2 for the child recreational user is due to exposure to methyl mercury via the consumption of fish.

[2] Cancer risk estimates within or less than the benchmark cancer risk range are considered acceptable and require no further evaluation. HIs less than the target HI of 1 are considered acceptable and require no further evaluation. For dioxins and furans in breast milk, an average daily dose less than 60 pg/kg-bw/day is considered acceptable and requires no further evaluation.

pg/kg-bw/day = picograms per kilogram body weight per day.

Table 3.16-12 Comparison of NGS Baseline and Proposed Action Blood Lead Model Results

Receptor	Geometric Mean of Blood Lead Level (µg/dL)			Percent >10 µg/dL		
	Baseline	3-Unit	2-Unit	Baseline	3-Unit	2-Unit
Resident	0.84	0.75	0.75	<0.001	<0.001	<0.001
Resident-Gardener	0.82	0.71	0.7	<0.001	<0.001	<0.001
Resident-Farm Family	0.95	0.69	0.69	<0.001	<0.001	<0.001
Benchmark[1]	5 (CDC Reference Blood Lead Level) 10 (USEPA Benchmark Blood Lead Level)					

[1] If receptor modeled lead levels are less than the CDC (5 µg/dL) and USEPA (10 µg/dL) blood lead level benchmarks, then modeled blood lead levels are considered acceptable and require no further evaluation.

CDC = Centers for Disease Control.

µg/dL = micrograms per deciliter.

As presented in **Table 3.16-13**, the potential risk from NGS Baseline and Future NGS 3-Unit Operation + proposed KMC 8.1 million tpy at NGS HHRA results predicted that the excess lifetime cancer risks were within the USEPA acceptable cancer risk range (1×10^{-4} to 1×10^{-6}). The noncancer HIs were less than or equal to the USEPA target HI of 1 for all NGS receptors. The estimated chronic HIs ranged from 0.05 to 0.2 at the maximum exposed individual for child residents, child resident gardeners, child resident farmers, and commercial workers due to combined NGS and proposed KMC impacts. NGS contributes approximately 99 percent of the NGS and proposed KMC combined impact (Ramboll Environ 2016a). The results of the Baseline and Future Operation HHRA concluded that negligible impact on human health was identified in the vicinity of NGS.

The proposed KMC impact to the recreational users within the NGS study area was not evaluated because the recreational users are mostly located near the Lake Powell and Colorado River areas, to the north and west of NGS. The overlapping area of proposed KMC and NGS modeling domain is about 50 km southeast of NGS and is outside the ranges of the waterbodies and watersheds analyzed in the HHRA. The impact from proposed KMC is extremely low for the recreational users at extended distance from proposed KMC and therefore was considered negligible. Future operation contributes to approximately 52 percent of the total estimated cancer risk. The chronic HI for the child recreational user is equal to 1. The risk from the baseline scenario contributes to more than 99 percent of the total noncancer HI for recreational users under this scenario.

Table 3.16-13 NGS HHRA Results: Baseline and Future Operations

Receptor	NGS Baseline		NGS 3-Unit Operation		Proposed KMC 8.1 million tpy		NGS-KMC 8.1 million tpy at NGS		Baseline + Future Operation	
	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index
Resident	2E-06	0.1	3E-06	0.06	4E-08	0.0002	3E-06	0.06	5E-06	0.2
Resident-Gardener	5E-06	0.7	3E-06	0.06	4E-08	0.0002	3E-06	0.06	8E-06	0.8
Resident-Farm Family	4E-05	0.8	4E-05	0.2	4E-08	0.0002	4E-05	0.2	8E-05	1
Recreational User	4E-06	1.2[1]	3E-08	0.01	NA	NA	3E-08	0.01	4E-06	1.2[1]
Commercial Worker	5E-07	0.02	9E-06	0.05	9E-09	0.00005	9E-06	0.05	1E-05	0.07

[1] The HI of 1.2 for the child recreational user is due to exposure to methyl mercury via the consumption of fish.

For the risk scenario of the NGS baseline combined with the NGS 2-Unit Operation HHRA, all cancer risk estimates were within the USEPA acceptable cancer risk range. All HI estimates were equal to or less than the target USEPA benchmark of 1. Because the potential cancer and noncancer risks to all human receptors were considered acceptable, the impact to human health is negligible.

Key uncertainties associated with the calculations and assumptions used in the NGS Future Operation HHRAs are similar to those associated with the NGS baseline HHRA: COPC selection, toxicity values (particularly the unit risk factor for DPM), estimation of EPCs, exposure parameters, exposure pathways. Because of the inherent health-protective nature of the assumptions used in the Future Operation HHRAs, the analyses are likely to result in overestimates of exposure and ensure protectiveness of human health in the overall assessment.

3.16.5.3.1.2 Proposed Kayenta Mine Complex – Proposed Action Risk Case

Potential health risks associated with fugitive dust and emissions related to mining activity are the focus of the proposed KMC HHRA under the Proposed Actions scenarios: 8.1 million tpy (to support NGS 3-Unit Operation) and 5.5 million tpy (to support NGS 2-Unit Operation). Potential risks from airborne chemicals of potential concern were evaluated quantitatively on a site-wide basis, while potential risks for the soil and food exposure pathways were evaluated qualitatively because soil concentrations attributable to mining 8.1 million tpy and 5.5 million tpy were very small.

For the proposed KMC 8.1 million tpy scenario, soil concentrations derived from mining activities were based on deposition of fugitive dust modeled for each phase of mining activity at the proposed KMC. Deposition for each phase was based on a representative year for each of the three phases of mining operations identified for 8.1 million tpy; 2027, 2034, and 2042. Total suspended particulate and PM_{10} chemicals of potential concern concentrations were based on source concentration data for overburden and coal obtained from the 2014 sampling program. Steady state soil concentrations for 8.1 million tpy for each phase were calculated based on HHRAP equations. For quantitative analysis of proposed KMC air impacts, 95 percent upper confidence limits were used. DPM air concentrations were modeled by McVehil-Monnett Associates, Inc. (2016).

For the proposed KMC 5.5 million tpy scenario, soil concentrations derived from mining activities were based on deposition of fugitive dust modeled for each phase of mining activity at proposed KMC. Deposition for each phase was based on a representative year for each of the four phases of mining operations identified for 5.5 million tpy; 2022, 2027, 2036, and 2043.Total suspended particulate and PM_{10} chemicals of potential concern concentrations were based on source concentration data for overburden and coal obtained from the 2014 sampling program. Steady state soil concentrations for 5.5 million tpy for each phase were calculated based on HHRAP equations. For quantitative analysis of proposed KMC air impacts, 95 percent upper confidence limits were used.

<u>Proposed KMC HHRA Results</u>

The proposed KMC 5.5 million tpy scenario represents the lower end of the range of potential emissions from the Proposed Action in terms of coal extraction rate. There was virtually no difference in cancer risk estimates and HIs for the 8.1 million tpy compared to the 5.5 million tpy. As presented in **Table 3.16-14**, the cancer risk estimates for the receptors from the 5.5 million tpy and 8.1 million tpy were 2.0×10^{-6} and at the lower end of the USEPA acceptable cancer risk range. The HIs under the 5.5 million tpy and 8.1 million tpy scenario were 0.02 and less than the USEPA target HI of 1. Because the cancer and noncancer risk estimates were below the benchmark values, they required no further evaluation.

Table 3.16-14 Comparison of Proposed KMC Baseline to Proposed Action Risk Cases for Resident, Gardener, and Farmer Exposure Scenarios

Risk Case	Baseline		8.1 million tpy		5.5 million tpy		NGS at Proposed KMC (3-Unit Operation)		NGS at Proposed KMC + 8.1 million tpy		Baseline + NGS at Proposed KMC + 8.1 million tpy	
	Cancer Risk[1]	Hazard Index[2]	Cancer Risk[1]	Hazard Index[2]	Cancer Risk[1]	Hazard Index[2]	Cancer Risk[1]	Hazard Index[2]	Cancer Risk[1]	Hazard Index[2]	Cancer Risk[1]	Hazard Index[2]
Resident	6E-06	0.9	2E-06	0.02	2E-06	0.02	3E-08	0.005	2E-06	0.02	8E-06	0.9
Resident -Gardener	9E-06	1.1[3]	2E-06	0.02	2E-06	0.02	3E-08	0.005	2E-06	0.02	1E-05	1.1[3]
Resident-Farm Family	2E-05	1.9[4]	2E-06	0.02	2E-06	0.02	3E-08	0.005	2E-06	0.02	2E-05	1.9[4]

1 Cancer risk estimates within or less than the benchmark cancer risk range are considered acceptable and require no further evaluation.

2 HIs less than or equal to the target HI of 1 are considered acceptable and require no further evaluation.

3 A HI of 1.1 for the resident gardener child exceeded the target HI of 1 and required further evaluation consisting of a target organ analysis. The conclusions of the target organ analysis performed for the resident farmer child also apply to the resident gardener child.

4 A HI of 1.9 exceeded the target HI of 1 and required further evaluation consisting of a target organ evaluation. Because the target organ evaluation for the resident farmer child exposure scenario demonstrated all target organ HIs were acceptable, a similar evaluation was not performed for any other scenario or receptors.

Potential impacts from NGS emissions on the proposed KMC permit area were evaluated at a grid cell located 80 km from NGS and approximately 50 km from the center of the proposed KMC (**Figure 3.16-4**). The impacts at that location were conservatively assumed to occur across the entire proposed KMC at those concentrations.

As presented in **Table 3.16-14**, the estimated cancer risks for chemicals of potential concern from NGS emissions modeled to the proposed KMC permit boundary from particulate matter with an aerodynamic diameter of 10 microns or less for the 3-Unit Operation NGS scenario were 3×10^{-8}, which is less than the USEPA cancer risk range of 1×10^{-4} to 1×10^{-6}.

The chronic HI for a proposed KMC resident from airborne NGS emissions during future operation is 0.005 for the 3-Unit Operation NGS scenario. These cancer and noncancer risks are below benchmark values and have negligible impact on human health.

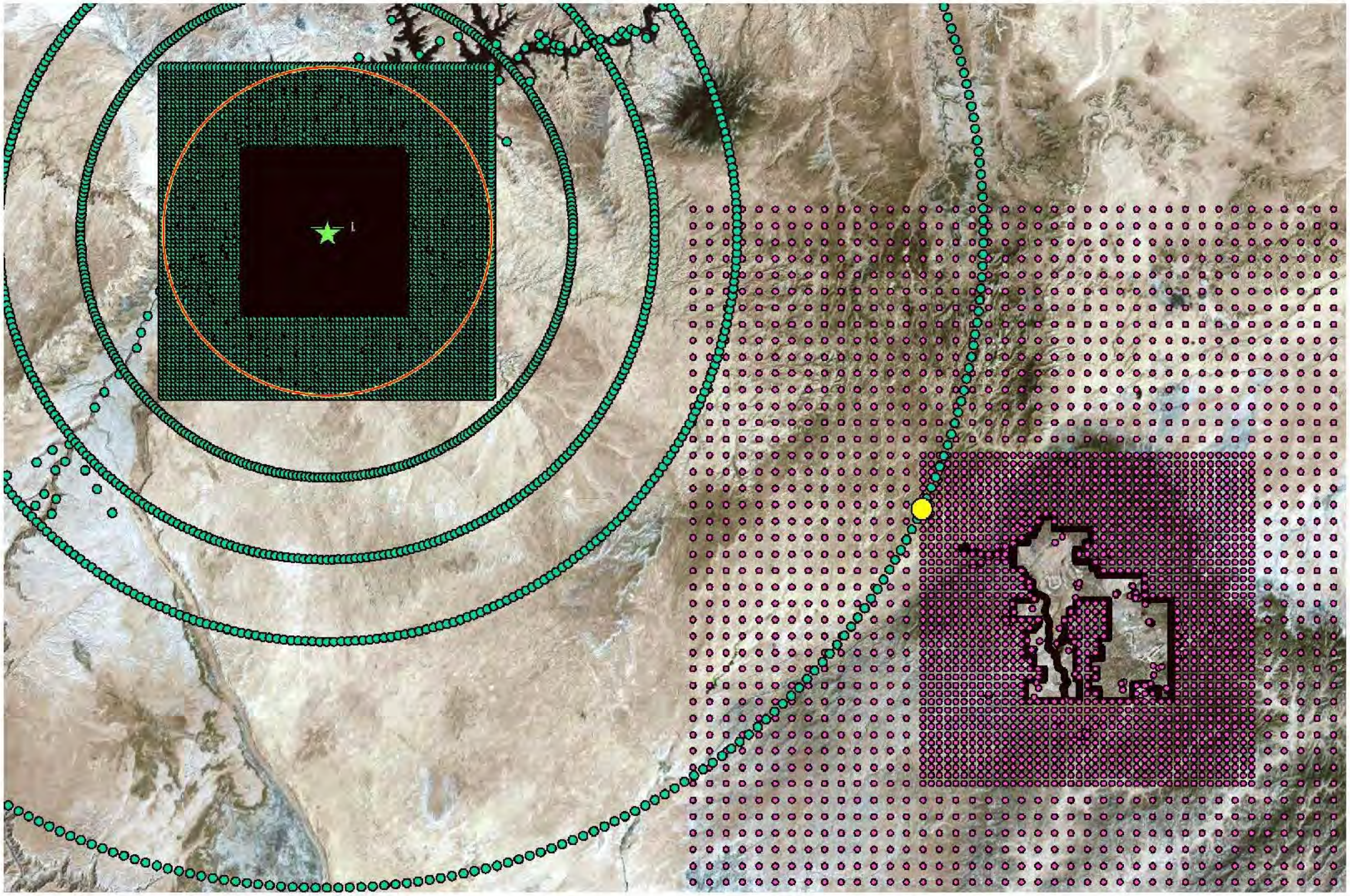
As presented in **Table 3.16-14**, the estimated cancer risks for chemicals of potential concern from NGS emissions modeled to the proposed KMC permit boundary in combination with the proposed KMC 8.1 million tpy scenario were 2×10^{-6}, which is within the USEPA cancer risk range of 1×10^{-4} to 1×10^{-6}. The addition of baseline to the NGS emissions modeled to the proposed KMC permit boundary in combination with the proposed KMC 8.1 million tpy scenario increases the risk estimates slightly but they are still within the USEPA cancer risk range of 1×10^{-4} to 1×10^{-6}. These cancer risk estimates are below benchmark values and have negligible impact on human health.

The chronic HIs for a proposed KMC resident from airborne NGS emissions during future operation plus the addition of the proposed KMC 8.1 million tpy scenario are 0.02 for the 3-Unit Operation NGS scenario. As presented in **Table 3.16-14**, the addition of baseline to the NGS emissions modeled to the proposed KMC permit boundary in combination with the proposed KMC 8.1 million tpy scenario increases the HIs to slightly above the target HI of 1 for the resident gardener and the resident farmer. Because the target organ evaluation for the resident farmer child exposure scenario demonstrated that all target organ HIs were acceptable, a similar evaluation was not performed for any other scenario or receptors. These noncancer risk estimates are below benchmark values and have negligible impact on human health.

Lead is evaluated separately for the 5.5 million tpy and 8.1 million tpy options for noncancer health risk using the USEPA's IEUBK model (USEPA 2010). Predicted average air lead concentrations across the site over all phases of mine operations are 0.000006 $\mu g/m^3$ and 0.0000083 $\mu g/m^3$ for the 5.5 million tpy and 8.1 million tpy options, respectively. The National Ambient Air Quality Standards lead standard is 0.15 $\mu g/m^3$. Based on these data, the IEUBK model predicted no quantitative impact on child blood lead levels (<10µg/dL) even for the resident farmer child exposure scenario, which is the highest exposure scenario. The probability of a child's blood lead exceeding the CDC reference level (5 µg/dL) for the proposed KMC is less than 0.0001 percent.

Uncertainty Analysis – Proposed Action Risk Case

The primary source of uncertainty for the Proposed Action risk case was the Inhalation Unit Risk (IUR) factor for DPM that was used to calculate cancer risks. USEPA has not established an IUR for DPM. The IUR developed by California Environmental Protection Agency was selected for use in the proposed KMC HHRA as the IUR with the best estimate currently available. There is considerable uncertainty surrounding this IUR and alternative DPM IURs proposed by a variety of sources could potentially increase or decrease the Proposed Action risks by a factor of up to 10 fold. However, even if the DPM IUR were to change by a factor of 10, the Proposed Action cancer risk estimates would still be within the acceptable regulatory risk range.



- ★ Navajo Generating Station (NGS)
- NGS receptor used in NGS @ KMC Impact Analysis
- NGS receptor used in NGS @ KMC Impact Analysis
- Proposed KMC
- NGS Receptors
- KMC Receptors

Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 3.16-4
Navajo Generating Station at Proposed KMC Grid Cell

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7/19/2016

Another potential source of uncertainty for the Proposed Action risk case was the air modeling used to estimate potential COPC air concentrations from proposed KMC mining activities. Air models used to support the proposed KMC HHRA are complex and rely on key assumptions such as estimated emission rates, meteorological conditions, and transport mechanisms to estimate airborne concentrations of COPCs. The models used for the proposed KMC HHRA are recommended by USEPA and are generally based on conservative assumptions. In most cases, site-specific assumptions regarding emission rates were either worst-case or above-average and inhalation EPCs were therefore more likely to over-estimate than underestimate exposures. The uncertainty associated with the air models for the proposed KMC HHRA is probably best described as low to moderate.

The potential cancer risk estimates and noncancer HIs are likely over-estimated due to the conservative approach used in the proposed KMC HHRA to evaluate impacts on proposed KMC residential areas from NGS emissions. COPC estimated concentrations were modeled to a point that was 15 km from the proposed KMC lease boundary and used to calculate cancer risks and noncancer HIs for residents based on these air concentrations. The impact of this source of uncertainty is a slight overestimate of risks, since NGS emissions were already quite low at the modeling grid cell and concentrations would be expected to decrease slightly as the distance from NGS increased.

3.16.5.3.1.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

The communication sites include propane-fired backup generators that provide backup power. Many of the sites are operated and maintained by other users. Given the relatively infrequent testing that is applied to these facilities, the remote locations, and the relatively low emission rates associated with propane-fired units, the air quality emissions and impacts on existing air quality conditions are assumed to be minimal and therefore, the impact on human health would be negligible. Maintenance activities for the communication sites, transmission lines, and access roads would include vehicle traffic (vehicle exhaust and fugitive dust from unpaved roads), but the maintenance activities would be infrequent, short duration, and/or localized. For example, transmission line structure maintenance and repair would occur on an as-needed basis, routine actions such STS vegetation clearing would occur once every 5 years or more infrequently depending on need, repair of STS access roads and WTS and STS transmission tower infrastructure would occur along localized sections of the lines or roads, and annual maintenance of WTS access roads would occur once or twice a year but equipment would move through the areas quickly. Therefore, emissions of future operations are considered minimal, and because these impacts are infrequent, short duration, and localized, and thus cause very little effect, the human health impacts are considered negligible.

3.16.5.3.2 Public Health

This section addresses the public health impacts associated with the proposed power plant and mine operations. **Table 3.16-1** summarizes the approach to evaluating public health impacts and identifies the health categories selected for further evaluation. The potential public health impacts with regard to environmental air quality, economy, public services/infrastructure, and demographics are further considered in this section for the Proposed Actions at NGS and proposed KMC. Section 3.16.3 evaluated the affected environment as it relates to the categories selected for further consideration. This section evaluates the magnitude of the potential health issues selected for further evaluation (both positive and negative) on the local community and the cumulative impacts. **Table 3.16-11** summarizes the assigned impacts described in the following sections, and presents the overall public health impact rating of each impact.

3.16.5.3.2.1 Environmental Air Quality and Public Health

As indicated on **Table 3.16-15**, possible health impacts associated with air emissions from the NGS and proposed KMC were noted. As discussed in Section 3.16.4.4, the public health impacts associated with air quality focus on exposures to particulate matter, specifically $PM_{2.5}$. Thus, this discussion focuses on the potential impacts to public health associated with particulate emissions from the proposed NGS and proposed KMC operations.

<u>Navajo Generating Station</u>

The NGS may operate as either a 3-Unit Operation or 2-Unit Operation. The 3-Unit Operation and 2-Unit Operation represent an upper and lower operational bound for the Proposed Action. The Proposed Action would result in a continuation of existing emissions and impacts, except for proposed additional controls related to SCR installation at NGS or the potential shutdown or curtailment of a unit at NGS. SCR installation at NGS would reduce the impact from historical operations through 2019, and may lead to a reduced impact on air quality and air quality related values in the region. Section 3.1 details the potential impacts to air quality associated with the proposed operations of the NGS.

Tables 3.1-12 and **3.1-13** present the results of the predicted emissions resulting from the NGS 3-Unit Operation and 2-Unit Operation, respectively. Maximum impacts of NGS on ambient concentrations of $PM_{2.5}$ are to receptors that are very near the NGS boundary. The predicted $PM_{2.5}$ emissions from the 3-Unit Operation and 2-Unit Operation are virtually the same. The existing background 24-hour $PM_{2.5}$ concentration is 20.8 $\mu g/m^3$, based on current air quality levels measured from the Glen Canyon ambient air monitoring station, approximately 2.7 miles west of downtown Page, Arizona, and approximately 6 miles west-northwest of the NGS. The predicted 3-Unit Operation emissions would result in predicted 24-hour $PM_{2.5}$ concentrations of 11.9 $\mu g/m^3$, and would increase the total 24-hour $PM_{2.5}$ concentrations to 32.7 $\mu g/m^3$. Though the maximum impacts associated with proposed NGS operations could potentially increase the current 24-hour $PM_{2.5}$ concentrations by 57 percent, the maximum cumulative impact on 24-hour $PM_{2.5}$ concentrations of 32.7 $\mu g/m^3$ would still meet the NAAQS criteria for 24-hour $PM_{2.5}$ of 35 $\mu g/m^3$ for both the 3-Unit Operation and 2-Unit Operation. Likewise, the predicted impacts of NGS Operations on the annual average $PM_{2.5}$ concentrations also would meet the NAAQS criteria for annual $PM_{2.5}$ of 12 $\mu g/m^3$. Specifically, the existing background annual average $PM_{2.5}$ concentration is 5.9 $\mu g/m^3$, based on current air quality levels measured from the Glen Canyon ambient air monitoring station. The predicted 3-Unit Operation emissions would result in predicted annual average $PM_{2.5}$ concentrations of 1.8 $\mu g/m^3$, and would increase the total annual average $PM_{2.5}$ concentrations to 7.6 $\mu g/m^3$, which is only 64 percent of the NAAQS criteria of 12 $\mu g/m^3$. The maximum $PM_{2.5}$ impact occurs at the NGS boundary, and the impacts rapidly decline with distance from NGS. Within 1 km from the NGS boundary, the maximum impact on 24-hour $PM_{2.5}$ concentrations is reduced from 32.7 $\mu g/m^3$ to about 24 $\mu g/m^3$ and impacts in all other directions are well below the ambient standard. Likewise, the maximum predicted impact on annual $PM_{2.5}$ concentrations of 7.6 $\mu g/m^3$ is on the NGS boundary and the impacts decline with distance from NGS. Because $PM_{2.5}$ concentrations meet NAAQS criteria, proposed NGS Operations will have little to no effects on the health of the general population.

Table 3.16-15 Proposed Project Public Health Impacts

Main Health Outcome	Specific Impact[1]	Project Area	Positive or Negative Health Impact?	Pathway of Health Impact	Magnitude/ Consequence of Impact	Likelihood/ Probability of Impact	Overall Impact on Public Health (Magnitude x Likelihood)[2]
Chronic Disease	Exacerbation of existing conditions for sensitive subpopulations (asthmatics, diabetics, others with compromised respiratory/circulatory systems)	NGS and proposed KMC	Negative	Particulate Inhalation	Low	Low	Minor
	Continued or increased access to health care	**NGS and proposed KMC**	**Positive**	**Indirect**	**Medium**	**High**	**Major**
Infectious disease	Increase in respiratory infections for sensitive subpopulations with respiratory health complications	NGS and proposed KMC	Negative	Particulate Inhalation	Medium	Low	Minor
	Continued or increased access to health care	**NGS and proposed KMC**	**Positive**	**Indirect**	**Medium**	**High**	**Major**
Nutrition	Temporary loss of livestock grazing areas	Proposed KMC	Negative	Indirect	Low	Medium	Minor
	Impacts to cultural resources	Proposed KMC	Negative	Indirect	Low	Low	Minor
	Continued or increased resources available to purchase healthy foods for the family	**NGS and proposed KMC**	**Positive**	**Indirect**	**Medium**	**High**	**Major**
Well Being or Psychosocial	Increase in stress or annoyance levels for populations living nearest to the mining areas due to noise and vibration	Proposed KMC	Negative	Noise and vibration	Low	High	Moderate
	Impacts to cultural resources	Proposed KMC	Negative	Direct and Indirect	Low	Low	Minor
	Increased stress due relocation of residents within the mining zones	Proposed KMC	Negative	Indirect	Low	High	Moderate
	Decreased stress due to more solid economic situation for the family	**NGS and proposed KMC**	**Positive**	**Indirect**	**Medium**	**High**	**Major**

Table 3.16-15 Footnotes:

[1] Impacts are for both 3-Unit Operation and 2-Unit Operation scenarios unless specifically noted; positive health effects indicated in **Bold**

[2]

Magnitude/Consequence of Impact	Likelihood of Occurrence of Health Impact		
	Low (unlikely to occur)	**Medium** (likely to occur sometimes)	**High** (likely to occur often)
None	negligible	negligible	negligible
Low	minor	minor	moderate
Medium	minor	moderate	major
High	moderate	major	major

Proposed Kayenta Mine Complex

The Kayenta Mine directly supports NGS and includes operations that also lead to air emissions. The Proposed Action at Kayenta Mine includes a range of mining level activity that is consistent with the 3-Unit Operation and 2-Unit Operation at NGS. For this facility the target production is set at 5.5 million tpy and 8.1 million tpy of coal production to meet the NGS scenario coal demand. Emissions of criteria pollutants are generated by mining operations (coal and overburden removal and transport), coal preparation plant activities (coal transfers, crushing, screening, stockpiling) and wind erosion of stockpiles and disturbed areas. The majority of these emissions consist of fugitive and process particulate matter (total suspended particulates, PM_{10}, and $PM_{2.5}$). Section 3.1 details the potential impacts to air quality associated with the proposed operations of the Kayenta Mine.

Receptors for modeling impacts were placed at the proposed KMC boundary and at specific residence receptors within the mine lease area. Most of the maximum impacts occur near the proposed KMC lease boundary. **Tables 3.1-21** and **3.1-22** present the results of the maximum modeled design concentrations at the boundary and at the residence receptors, respectively, resulting from both the 5.5 million tpy and 8.1 million tpy of coal production scenarios. Background air quality concentrations were based on data collected at the proposed KMC or at regional stations that either are representative of remote locations or are conservative estimates of the regional background. Because there virtually are no other significant emission sources near the proposed KMC the overall approach to background concentrations is very conservative. All model results indicate that the impacts, including the calculated background concentrations, are below the ambient air quality standards. The predicted $PM_{2.5}$ emissions from the 5.5 million tpy and 8.1 million tpy of coal production scenarios are virtually the same.

The background 24-hour $PM_{2.5}$ concentration is 13 $\mu g/m^3$. The predicted impacts at the proposed KMC boundary would result in predicted 24 hour $PM_{2.5}$ concentrations of 6.8 and 5.7 $\mu g/m^3$ under the 5.5 million tpy and 8.1 million tpy of coal production scenarios, respectively, resulting in total 24 hour $PM_{2.5}$ concentrations of 19.8 and 18.7 $\mu g/m^3$, respectively. The predicted impacts at the proposed KMC resident receptors would result in predicted 24 hour $PM_{2.5}$ concentrations of 3.4 and 4.0 $\mu g/m^3$ under the 5.5 million tpy and 8.1 million tpy of coal production scenarios, respectively, resulting in total 24 hour $PM_{2.5}$ concentrations of 16.4 and 17 $\mu g/m^3$, respectively. The maximum cumulative impact on maximum 24-hour $PM_{2.5}$ concentrations associated with each coal production scenario would meet the NAAQS criteria for 24-hour $PM_{2.5}$ of 35 $\mu g/m^3$. Likewise, the predicted impacts on the annual average $PM_{2.5}$ concentrations also would meet the NAAQS criteria for annual $PM_{2.5}$ of 12 $\mu g/m^3$. Specifically, the background annual average $PM_{2.5}$ concentration is 4.7 $\mu g/m^3$. Impacts at the proposed KMC boundary would result in predicted annual average $PM_{2.5}$ concentrations of 1.3 and 1.2 $\mu g/m^3$ under the 5.5 million tpy and 8.1 million tpy of coal production scenarios, respectively, resulting in total annual average $PM_{2.5}$ concentrations of 6.0 and 5.9 $\mu g/m^3$, respectively. The predicted impacts at the proposed KMC residential receptors would result in predicted annual average $PM_{2.5}$ concentrations of 0.8 and 1.0 $\mu g/m^3$ under the 5.5 million tpy and 8.1 million tpy of coal production scenarios, respectively, resulting in total annual average $PM_{2.5}$ concentrations of 5.5 and 5.7 $\mu g/m^3$, respectively, which is only approximately 50 percent of the annual $PM_{2.5}$ NAAQS criteria of 12 $\mu g/m^3$. Because $PM_{2.5}$ concentrations meet NAAQS criteria, proposed KMC Operations will have little to no effects on the health of the general population.

Sensitive Subpopulations

There is some information that the NAAQS criteria may be insufficiently protective for sensitive subpopulations.

A broad range of health effects have been associated with ambient particulate matter, as described in Section 3.16.3. The NAAQS are set at a level expected to protect public health with an adequate margin of safety, taking into consideration effects on susceptible populations (USEPA 2012). However, it is still not clear whether there is a threshold concentration below which adverse health effects are not seen, even for sensitive populations. The detection of a threshold level for the effects of particulate matter on mortality has proven to be very difficult. The current evidence shows limited support for use of a “no-threshold” model (USEPA 2012, 2009b). Since individual thresholds vary from person to person due to individual differences in susceptibility and pre-existing disease conditions (i.e., asthma or reactive airway disease), it is extremely difficult to mathematically demonstrate that a clear threshold exists in population studies. This is especially true if the most sensitive members of a population (generally children and the elderly) have pre-existing conditions (e.g., asthma) that make them unusually sensitive even down to very low concentrations. Because of these issues with determining a threshold, there may be some health effects associated with $PM_{2.5}$ for susceptible individuals even if ambient $PM_{2.5}$ levels meet the air quality criteria. Levy et al. (2002) estimated that a 1 $\mu g/m^3$ increase in daily $PM_{2.5}$ concentration could result in a 1 percent increase in asthma-related emergency room visits.

The predictive air dispersion modeling presented in Section 3.1 indicates that maximum impacts associated with NGS operations occur at the site boundary and decrease rapidly with increasing distance from the site. As discussed in Section 3.14, the overall area surrounding the NGS is sparsely populated with the exception of the City of Page and the developable area of LeChee, is 10 miles south of Page. Impacts associated with NGS Operations at these receptor points are negligible with respect to background. Even if sensitive individuals are present in the City of Page or LeChee, they are unlikely to be affected.

However, as detailed in Section 3.14, approximately 150 Navajo residents live in dispersed houses within the Kayenta permit boundary (OSMRE 2011, 2008). Socioeconomic status is a strong determinant of individual health (WHO 2008). As discussed in Section 3.14, the area surrounding the mine is a relatively low income area. Therefore, some residents may be in poorer health due to their socioeconomic conditions and/or more limited access to health care. Thus, the Navajo people residing within or near the proposed KMC permit boundary is the population of greatest concern for exposure to $PM_{2.5}$. The analysis of local health information (Section 3.16.3) found that of the 15 counties in Arizona, Navajo County ranks among the unhealthiest in the state. Life expectancy rates are lower, mortality rates are higher, and many behavioral risk factor rates exceed the state averages. In Arizona, the prevalence of asthma is higher among lower income populations. Navajo County has among the highest asthma rates in the state, with an adult rate of 17.2 percent. Limited relevant information was found for assessing asthma prevalence and severity among Navajo Nation or Hopi Tribe members. Therefore, in addition to being a sensitive subpopulation based on socioeconomic conditions (WHO 2008), there could potentially be a higher proportion of people with asthma in the proposed KMC permit boundary than the state.

Due to the proximity of Navajo residents to the proposed KMC operations and relatively poor existing socioeconomic and health conditions of the Navajo community, potential increases in $PM_{2.5}$ emissions associated with mine operations could lead to some minor negative health effects for sensitive subpopulations. However, as discussed in Gradient (2016), uncertainty remains regarding associations between long-term exposure and adverse health effects, and between short-term exposures and adverse health effects. In addition, as presented in Section 3.1, maximum $PM_{2.5}$ impacts at the proposed KMC boundary and residential receptor grids are largely influenced by ambient background $PM_{2.5}$ concentrations and total impacts are well below the ambient air quality criteria. While small increases in ambient $PM_{2.5}$ concentrations over existing background concentrations could potentially exacerbate existing health conditions of sensitive subpopulations, most cases of health problems among the affected population are associated with causes unrelated to $PM_{2.5}$ exposure, including those found at higher rates in Navajo and Coconino County (e.g., lifestyle factors such as diet, inactivity, and alcohol consumption). Furthermore, use of wood or coal as an indoor fuel with inadequate domestic facilities could potentially result in $PM_{2.5}$ exposures far greater than those associated with proposed KMC operations (Gradient 2016). Therefore, the magnitude or consequence of the health impact of air quality is rated as “low” on **Table 3.16-11** (because some minor impacts could potentially occur for sensitive subpopulations), and the likelihood of the impacts also is rated as “low” on **Table 3.16-11** (because concentrations are predicted to be well below the ambient air criteria). This results in an overall public health rating of “minor”. There are no differences in impact findings between the 3-Unit Operation and 2-Unit Operation.

3.16.5.3.2.2 Economy and Public Health

As indicated on **Table 3.16-1**, potential positive health impacts associated with NGS-KMC proposed actions on local economic conditions were noted. Section 3.18 presents a detailed analysis of the impacts (both positive and negative) that the Proposed Action has on the socioeconomic conditions of the affected communities. In general, the sustained employment associated with continued operations of the NGS and proposed KMC and increased funds to Navajo and Hopi Tribes through extension of lease and coal royalties is expected to result in positive health impacts. The economic benefits associated with continued employment, and potentially increased employment opportunities, could lead to continued or improved access to health services, better nutrition, and better overall well-being. Furthermore, as described in Section 3.18, extending the operating life of NGS-KMC to 2044 would generate current and retirement income for many households beyond the operating life of the plant. Those benefits take on added importance given the persistent high unemployment and poverty among the Navajo.

The 3-Unit Operation of the NGS and associated proposed KMC activities to support the 3-Unit Operation provides the greatest economic benefit. As described in Section 3.18, implementation of the Proposed Action at NGS under the 2-Unit Operation results in many of the socioeconomic effects associated with the Proposed Action under the 3-Unit Operation, but at scaled back or reduced levels. For example, Proposed Action 3-Unit Operation sustains the current population in Page and nearby Navajo Chapters, while Proposed Action 2-Unit Operation could create lower employment levels resulting in population emigration from the region. Thus, the 2-Unit Operation has fewer economic benefits to the local community than the 3-Unit Operation at NGS. However, even under the 2-Unit Operation scenario, economic conditions would be vastly improved over a no action scenario where NGS and proposed KMC operations cease. Therefore, overall the Proposed Action at NGS and proposed KMC is expected to result in economic benefits to the affected community which will lead to positive public health impacts. The magnitude of impact shown on **Table 3.16-11** is “medium” and positive and the likelihood is rated as “high,” with an overall public health rating of “major” positive significance.” While the benefits for the 3-Unit Operation are expected to be higher than the 2-Unit Operation, there are no overall differences in public health impact findings between the 3-Unit Operation and 2-Unit Operation scenarios.

3.16.5.3.2.3 Public Services/Infrastructure and Public Health

No new public infrastructure would be required at the NGS and proposed KMC sites under the Proposed Action operations. Existing rail lines would continue to be utilized to transport coal from the proposed KMC to the NGS. As part of the Proposed Action, Navajo Route 41 would revert to its original alignment, which could lead to positive effects on public health due to the safety improvements associated with realignment. No negative health impacts associated with existing infrastructure are expected. In addition, no changes to existing services are anticipated under the Proposed Action, As discussed in Section 3.18, in general, existing infrastructure and service conditions are anticipated to remain relatively unchanged in the project impact area and the Navajo community would benefit from continued access to EMS from the PWCC clinic for life-threatening conditions. Therefore, overall the Proposed Action at NGS and proposed KMC is expected to result in no impacts to the affected community with regard to public services and infrastructure.

3.16.5.3.2.4 Demographics and Public Health

As indicated on **Table 3.16-1**, potential public health impacts associated with community demographics were noted. This section discusses the potential health impacts related to site land use and community health.

<u>Land Use</u>

Section 3.16.3 summarized the current land use patterns and demographics particularly relevant to health. The local community includes members of the Navajo Nation and the Hopi Reservation within

northern Coconino and Navajo counties, Arizona. No notable changes in land use patterns are anticipated in the vicinity of NGS based on the Proposed Action, as discussed in Section 3.14. Thus this discussion focuses on the public health impacts relevant to land use that are associated with proposed KMC operations. The following impacts and changes to land use in the vicinity of Kayenta Mine that could potentially impact public health were identified, and are discussed in greater detail below:

- Potential relocation of residents living within the mining zone;
- Potential impacts to lands used for livestock grazing;
- Noise and vibration disturbances during mine blasting; and
- Disturbance of cultural resources that might affect traditional tribal lifestyles.

Relocation of Residents

As the mine areas are developed, residents occasionally need to be relocated to different areas. PWCC incurs the expense to move or construct housing to a location agreed upon by the residents. As detailed in Section 3.14, under the Proposed Action 3-Unit Operation, mining would occur in the N-10, N-11 Ext, and J-21-W areas, as well as portions of the N-9, J-19 and J-21 areas of the proposed KMC. This could lead to relocation of up to 8 residences currently residing in the mining zones. Under the 2-Unit Operation no mining would occur in the N-10 area, which would result in an estimated two fewer residential relocations. PWCC consults with the affected residents and attempts to relieve some of the stress associated with relocation by helping them obtain homesite leases, performing the cultural surveys, and attempting to accommodate the family's preferences on location and replacement structures.

While no direct health impacts are anticipated from relocation, it is assumed that there could be some emotional stress associated with relocation that could potentially affect the overall well-being of those few residents who are relocated. This assumption is based on the comments and concerns expressed by community members through public meetings and hearings summarized in Chapter 1.0. The magnitude or consequence of the health impact of residential relocation is rated as “low” on **Table 3.16-11** (because some impacts to overall well-being and health, as well as quality of life, might occur for those few residents who are relocated), and the likelihood of the impact is rated as “high” on **Table 3.16-11** for those residences located within the future mining zones. This results in an overall public health rating of “moderate”. While fewer residences are expected to be relocated under the 2-Unit Operation compared to the 3-Unit Operation, the overall impact rating is the same for both scenarios.

Livestock Grazing

Many residents graze livestock (mainly cattle, sheep, and goats) on reclaimed and undisturbed lands within the proposed KMC for a food source and for economic and cultural reasons. Livestock grazing is the primary pre-mine and post-mine use of the land and occurs year-round. Other uses of the land by residents living within the permit boundary include the gathering of plants for food, medicine, cultural purposes, firewood gathering, and farming small agricultural plots (approximately 4 to 5 acres in size) typically used for growing corn (PWCC 2012 et seq.). The HHRA determined that no unacceptable health risk exist for residents consuming livestock that graze in the permit boundary or consuming plants harvested from within or near the mine site. Thus, no public health impacts are anticipated from consumption of livestock or plants under either the 3-Unit Operation or 2-Unit Operation scenario. However, as discussed in Section 3.14, as the mine areas are developed, up to six assigned grazing areas could be affected under the 3-Unit Operation until final reclamation is complete. This would number be reduced under the 2-Unit Operation. The loss of these grazing areas may be partially or completely offset due to the reclamation that has occurred on previously mined areas. Most of the reclaimed areas now provide a greater amount of forage vegetation than was available under pre-mine conditions. Regardless, the loss of these grazing areas could potentially impact the nearby residents. If livestock have to be relocated due to the loss of the grazing area, diets could be affected or loss of income could be experienced if livestock grazing provides an income source. However, the loss of grazing areas is temporary and compensation for affected grazing areas could offset the potential loss of income. As discussed in Section 3.14, after mining areas are fully reclaimed, the land will be restored to pre-mining conditions. The purpose of reclamation is to restore the affected lands to the approximate landforms that existed prior to mining and to establish a diverse, effective, and permanent vegetative cover similar in seasonal variety, diversity, and plant composition to the native vegetation on undisturbed lands surrounding the mining operation. Therefore, the magnitude or consequence of the health impact associated with the loss of grazing areas is rated as “low” on **Table 3.16-11** (because some impacts to overall well-being and health, as well as quality of life, might occur yet those impacts would be temporary until areas are fully reclaimed), and the likelihood of the impact is rated as “medium” on **Table 3.16-11** because loss of these four or five grazing areas may be partially or completely offset due to the reclamation that has occurred on previously mined areas. This results in an overall public health rating of “minor.” While fewer grazing areas are expected to be lost under the 2-Unit Operation compared to the 3-Unit Operation, the overall impact rating is the same for both scenarios.

Noise and Vibration

Noise is defined as “unwanted sound.” Sound levels for this project do not approach levels that have been associated with hearing impairment. There are some non-auditory impacts on human health due to noise at sound levels below those associated with ear impairment (WHO 1999), and this is an on-going area of research. Non-auditory effects due to noise in a community can contribute to stressors that may influence health such as:

- Reductions in quality of life (potentially work, home, and school life), as noise can disrupt speech and sleep, potentially leading to increases in stress and reduction in productivity (UCLA 2011);
- Effects on cardiovascular health via increases in blood pressure (Babisch 2011); and
- Changes in hormone levels related to a stress response (Evans et al. 2001).

In addition, noise can represent a nuisance with associated annoyance levels for those affected. There is not a clear delineation as to when an “annoyance” results in a stress significant enough to produce measureable health effects; thus, some community noise analyses are based on annoyance perception levels rather than health effects (U.S. Department of Transportation 2005). Providing further complication, the impacts of increased sound depend not just on the numerical increase in sound levels, but also on the intensity of the sound, the duration of the sound, and the sound setting (WHO 1999). Unexpected, short duration, high intensity sounds can have a worse effect than relatively steady sounds. Humans do appear to have an adaptive response to typical sound levels in their environment and once adaptation has occurred, sleep patterns are not affected (Stansfeld and Matheson 2003).

As discussed in Section 3.15, current noise and vibration at the NGS and associated facilities consists of an assortment of sounds at varying frequencies from typical plant operations, as well as noise associated with coal rail operations and maintenance actions on associated facilities. No noise impacts from NGS operation would occur outside the plant boundaries as there are no sensitive receptors within 3 miles of NGS or 200 feet of the Black Mesa & Lake Powell Railroad. However, sensitive noise receptors, including residents who live near or within the proposed KMC permit boundaries and within range of warning signals for blasting during mining operations would continue to experience noise from mining activities under the Proposed Action. Surface blasting occurs less than twice daily during weekdays from sunrise to sunset. However, residents would be notified well in advance of the blasting schedule, and notices posted in public locations. The number of warning and all-clear signals produced at blasting sites by an audible-speaker warning device would remain at or slightly below existing levels as overall coal production per year is not anticipated to increase, but may decrease under the 2-Unit Operation. Additionally, no blasting would be conducted within 0.5 mile of an occupied dwelling; therefore, residents in or near the blasting area would be evacuated prior to proceeding with any blasting actions. The noise reduction measures related to activities at mining sites would include maintenance of equipment exhaust systems and engine sound controls to manufactures' specifications and limiting blasting to daylight hours. Furthermore, natural topographic screening between mining operations and sensitive noise receptors could reduce noise for sensitive receptors. In addition to the distance of the sensitive noise receptors from the active mine areas, mining activities occur below grade, which result in the walls of the pit and spoil piles absorbing and attenuating some of the noise from mining activities.

Based on the noise sources associated with mining operations described in Section 3.15, existing sound levels for typical daytime noise levels, depending on the level of intensity of mining activities, and less depending upon distance from the noise source, are likely to range from 80 a-weighted decibels (dBA) to 95 dBA at 50 feet from equipment and reduce to 50 dBA to 70 dBA at 1,600 feet from equipment. For comparison, 40 dBA is relatively quiet and can be equated to the noise level of a residence at night, while 60 dBA is comparable to a normal conversation and is considered a comfortable noise level. Noise from a point source decreases rapidly with increasing distance. No blasting or mine operations will occur within 0.5 mile of a receptor. Thus, noise levels for residential receptors would be even lower. Blasting activities would continue to be conducted in accordance with administrative regulations established to minimize adverse impacts resulting from noise and vibration in 30 Code of Federal Regulations 816.67. Resulting noise and vibration impacts would not be expected to exceed federal regulations. Temporary effects from vibration and airblast levels within standards established in 30 Code of Federal Regulations 816.67 are not considered capable of producing injury or property damage, but could cause annoyance depending on the distance to the receptor (Mohamed 2010). Therefore, the magnitude or consequence of the health impact associated with noise and vibrations resulting from mining operations is rated as "low" on **Table 3.16-11** (because some impacts to overall well-being and health, as well as quality of life, might occur for those few residents located in close proximity), and the likelihood of the impact is rated as "high" on **Table 3.16-11** because of the daily mining operations and the regular and frequent blasting schedule. This results in an overall public health rating of "moderate." The overall impact rating is the same for both the 3-Unit Operation and 2-Unit Operation scenarios.

Cultural Resources

Section 3.17 discusses the impacts to cultural resources in the NGS-KMC Study Area. Tangible properties of traditional cultural importance can include, physical locations associated with the traditional beliefs concerning tribal origins, cultural history, or the nature of the world; locations where religious practitioners go, either in the past or present, to perform ceremonial activities based on traditional cultural rules or practice; ancestral habitation sites; trails; burial sites; and places from which plants, animals, minerals, and water possessing healing powers or used for other subsistence purposes may be taken. Some of these locations may be considered sacred to particular Native American individuals or tribal communities and loss of these resources could impact the lifestyle of those individuals. As detailed in Section 3.17, potential impacts to cultural resources through implementation of the Proposed Action are limited to the proposed KMC study area. Section 3.17 indicates that affected resources include archaeological sites, architectural resources, traditional cultural properties, and currently known or suspected human burials within or adjacent to areas to be mined. Though no direct impacts to public health are expected due to potential loss of cultural resources, traditional lifestyles could be impacted which could impact the general well-being of the local community. Measurement of the public health impact associated with loss of cultural resources is difficult because some individuals may be affected more than others. As discussed in Section 3.17, any impacts on historic properties that may result from the project alternatives would be resolved through implementation of the stipulations in the proposed KMC Programmatic Agreement in consultation with the Tribes and agencies. Thus, significant efforts will be used to avoid or mitigate potential impacts to cultural resources, thereby reducing the potential for public health impacts related to cultural resources. Therefore, the magnitude or consequence of the health impact associated with impacts to cultural resources is rated as "low" on **Table 3.16-11** (because some impacts to overall well-being, as well as quality of life, might occur), and the likelihood of the impact is rated as "low" on **Table 3.16-11** because efforts will be implemented to avoid or mitigate loss of cultural resources. This results in an overall public health rating of “minor.” The overall impact rating is the same for both the 3-Unit Operation and 2-Unit Operation scenarios.

Community Health

Section 3.16.3 details the existing community health conditions for the affected community. As discussed, the general health of the local community ranks poorly compared to the rest of the State of Arizona. As discussed in Gradient (2016), two reports published by ADHS provide perspective on the health of all Native Americans residing in the state, including Navajo and Hopi residents as well as those of other tribes (ADHS 2015a,b). These reports include observations that mortality rates of Native Americans in Arizona are elevated, relative to other state residents, for alcohol-induced causes, car accidents, diabetes, and unintentional injuries/accidents. Conversely, mortality rates of Native Americans in Arizona are lower on average than those for other state residents for lung cancer, chronic lower respiratory diseases, and heart disease. These observations indicate that lifestyle risk factors are a major driver in the overall well-being of the local community. While this public health evaluation does identify some level of health impacts associated with the Proposed Action, particularly associated with relocation of residents and noise and vibration nuisances that could impact the psychosocial state and overall well-being of the community, these potential impacts are likely negligible relative to the lifestyle risk factors that are contributing to the general health of the community.

In addition, through public meetings and hearings summarized in Chapter 1.0, a number of local community members have expressed concerns about family members suffering from chronic respiratory conditions that they believe is associated with plant and mine operations. As discussed above, the existing air quality conditions meet the air quality standards derived to protect the general population against adverse health effects. In addition, the modeled air emissions associated with the Proposed Action also are expected to meet air quality standards within the 50-km study area. Furthermore, the risk assessment sections evaluated human health risks associated with contaminant exposures through a number of exposure pathways (both direct and indirect exposures to emissions). The HHRA concluded that no unacceptable health risk is associated with the Proposed Action. Therefore, the available data and conservative modeling results indicate that no negative health effects are expected to be associated with Proposed Operations. A possible exception would be the potential health impacts to the sensitive subpopulations with existing conditions that could be exacerbated by increases (albeit, slight) in $PM_{2.5}$ emissions associated with the Proposed Action. It is important to note that, as discussed in Section 3.16.3, use of coal as an indoor fuel source is a common practice among the local community. Poorly ventilated stoves and boilers produce far higher exposures to particulates in indoor air than the Proposed Action would produce in outdoor air. The improper use of coal as an indoor fuel source could explain some of the symptoms of health described by the local community. Regardless, the opposition among some of the community members of the Proposed Action and the continued operation of the NGS and associated mining activities is recognized. Whether the community concerns are related to direct health effects associated with mine operations (regardless of what the data indicate) or indirect effects such as visual disturbances, loss of traditional and cultural lifestyles, public safety related to nearby mining operations, etc. (see further details in Sections 1.9 and 1.10), the opposition against the Proposed Action in itself could potentially cause emotional stress, leading to an impact on overall well-being and/or psychosocial health. The magnitude of public health impact directly associated with opposition to the mine by a limited number of individual members of the community is difficult to quantify. However, the community concerns were considered when assigning impact ratings for other public health categories in this assessment. Thus, the overall impacts to public health summarized on **Table 3.16-11** are assumed to account for the potential impacts associated with opposition of the mine by some community members.

3.16.5.3.3 Project Impact Summary – All Project Components

The impacts to human health from all project components are negligible because the potential cancer and noncancer risks are considered acceptable.

The public health evaluation concluded that potential impacts to the environment from all project components will result in minor or negligible health impacts to the general population of the affected community. Overall, the public health evaluation and the HHRAs concluded that major benefits to public health due to positive impacts on the socioeconomic conditions of the community could be achieved through implementation of the Proposed Action. However, potentially major negative impacts to the well-being or psychosocial health of the residents living within or near the proposed KMC mining zones was identified for the proposed KMC operations due to the emotional stress caused by relocation of residents and the health effects associated with the annoyance and nuisance of the noise generated through blasting and mining operations. The HHRA and public health evaluation collectively concluded that potential impacts to the environment will result in minor or negligible health impacts to the general population of the affected community.

3.16.5.3.4 Cumulative Impacts

The HHRA and the public health evaluation conclusions consider the cumulative effects associated with existing conditions and the additional potential future impacts associated with the Proposed Action of both the NGS and proposed KMC. The HHRA evaluated the potential health risks from exposure to chemical pollutants emitted from the NGS or proposed KMC during proposed operations, and other non-project related regional and global sources, while the public health evaluation considered health effects associated with impacts to environmental air quality by particulate emissions during NGS and proposed KMC proposed operations. The public health evaluation noted that a possible exception would be the potential minor health impacts to the sensitive subpopulations with existing conditions that could be exacerbated by increases (albeit, slight) in $PM_{2.5}$ emissions associated with the Proposed Action.

Details of the cumulative impacts on HHRA and public health evaluations are presented in the following subsections.

3.16.5.3.4.1 Human Health Risk Assessment

The total human health impact from Baseline, Future Operation (NGS 3-Unit Operation + Proposed KMC 8.1 million tpy at NGS) and other cumulative sources were included in the HHRA to evaluate total cumulative impacts. The total cumulative action evaluates current environmental conditions, the 3-Unit future operations associated with the project, the impacts from proposed KMC emissions under the 8.1 million tpy scenario on NGS, and (non-project related) regional and global emission sources (i.e., other cumulative sources, impacts of mercury from sources other than NGS and proposed KMC, including non-U.S. sources were characterized using mercury deposition data from the EPRI San Juan River Basin study [EPRI 2016]).

As presented in **Table 3.16-16**, the estimated excess lifetime cancer risks for all receptors at NGS are within the USEPA acceptable cancer risk range of 1×10^{-4} to 1×10^{-6} and require no further action. The chronic HI estimates for the resident, resident gardener, resident farmer and commercial worker are less than or equal to the USEPA benchmark of 1 and require no further action. The HI for the child recreational user is greater than the USEPA benchmark of 1. The driving pathway for the child recreational user is exposure to methyl mercury via consumption of fish. Note that the Arizona Game and Fish Department issued a fish consumption advisory in 2012 recommending that people, including pregnant women and children, limit their consumption of striped bass caught in the southern portion of Lake Powell (AGFD 2012), which is the major surface waterbody to which a recreational user may be exposed. Based on an unacceptable noncancer hazard of 2 for the ingestion of fish by the recreational user under the NGS Total Cumulative Impact scenario, a low impact on human health was identified. The impact is considered minor because of the fish advisory (AGFD 2012) that likely limits the consumption of fish.

Table 3.16-16 NGS HHRA 3-Unit Operation Results for Total Cumulative Impacts

Receptor	Baseline		NGS 3-Unit Operation + Proposed KMC 8.1 million tpy at NGS		Other Cumulative Sources		Total Cumulative Impact	
	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index
Resident	2E-06	0.1	3E-06	0.06	3E-11	0.0006	5E-06	0.2
Resident-Gardener	5E-06	0.7	3E-06	0.06	3E-11	0.002	8E-06	0.8
Resident-Farm Family	4E-05	0.8	4E-05	0.2	3E-11	0.003	8E-05	1
Recreational User	4E-06	1.2[1]	3E-08	0.01	3E-13	1.1	4E-06	>1
Commercial Worker	5E-07	0.02	9E-06	0.05	8E-12	0.00006	1E-05	0.07

[1] The HI of 1.2 for the child recreational user is due to exposure to methyl mercury via the consumption of fish.

The total human health impact from Baseline, Future Operation (NGS 2-Unit Operation + Proposed KMC 8.1 million tpy at NGS) and other cumulative sources were included in the HHRA to evaluate total cumulative impacts. The total cumulative action evaluates current environmental conditions, the 2-Unit future operations associated with the project, the impacts from proposed KMC emissions under the 8.1 million tpy scenario on NGS, and (non-project related) regional and global emission sources (i.e., other cumulative sources, impacts of mercury from sources other than NGS and proposed KMC, including non-U.S. sources were characterized using mercury deposition data from the EPRI San Juan River Basin study [EPRI 2016]).

As presented in **Table 3.16-17**, the estimated excess lifetime cancer risks for all receptors at NGS are within the USEPA acceptable cancer risk range of 1×10^{-4} to 1×10^{-6} and require no further action. The chronic HI estimates for the resident, resident gardener, resident farmer, and commercial worker are less than or equal to the USEPA benchmark of 1 and require no further action. The HI for the child recreational user is greater than the USEPA benchmark of 1. The driving pathway for the child recreational user is exposure to methyl mercury via consumption of fish. Note that the Arizona Game and Fish Department issued a fish consumption advisory in 2012 recommending that people, including pregnant women and children, limit their consumption of striped bass caught in the southern portion of Lake Powell (AGFD 2012), which is the major surface waterbody to which a recreational user may be exposed. Based on an unacceptable noncancer hazard for the ingestion of fish by the recreational user under the NGS Total Cumulative Impact scenario, a low impact on human health was identified. The impact is considered minor because of the fish advisory (AGFD 2012) that likely limits the consumption of fish.

Table 3.16-17 NGS HHRA 2-Unit Operation Results for Total Cumulative Impacts

Receptor	Baseline		NGS 2-Unit Operation + Proposed KMC 8.1 million tpy at NGS		Other Cumulative Sources		Total Cumulative Impact	
	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index
Resident	2E-06	0.1	2E-06	0.04	3E-11	0.0006	4E-06	0.2
Resident-Gardener	5E-06	0.7	2E-06	0.04	3E-11	0.002	8E-06	0.8
Resident-Farm Family	4E-05	0.8	4E-05	0.2	3E-11	0.003	8E-05	1

Table 3.16-17 NGS HHRA 2-Unit Operation Results for Total Cumulative Impacts

Receptor	Baseline		NGS 2-Unit Operation + Proposed KMC 8.1 million tpy at NGS		Other Cumulative Sources		Total Cumulative Impact	
	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index
Recreational User	4E-06	1.2[1]	3E-08	0.01	3E-13	1.1	4E-06	>1
Commercial Worker	5E-07	0.02	9E-06	0.04	8E-12	0.00006	1E-05	0.06

[1] The HI of 1.2 for the child recreational user is due to exposure to methyl mercury via the consumption of fish.

The total human health impact from Baseline, Future Operation 8.1 million tpy scenario, NGS 3-Unit Operation at proposed KMC and other cumulative sources was included in the HHRA to evaluate total cumulative impacts. The total cumulative action evaluates current environmental conditions, the future operations associated with the project, air quality impacts from NGS operations throughout the proposed KMC, and (non-project related) regional and global emission sources from arsenic, selenium and mercury.

As presented in **Table 3.16-18**, the estimated excess lifetime cancer risks for all proposed KMC resident receptors are within the USEPA acceptable cancer risk range of 1 x 10^{-4} to 1 x 10^{-6} and require no further action. The chronic HIs range from 0.9 for the child resident to 1.9 for the child resident farmer, and due largely to the noncancer baseline risk. Because the target organ evaluation for the resident farmer child exposure scenario demonstrated all target organ HQs and HIs were acceptable, no further action is required. Because all cancer and noncancer risks were considered acceptable, the impact to human health based on the total cumulative impact at the proposed KMC is considered negligible.

Table 3.16-18 Proposed KMC HHRA Results for Total Cumulative Impacts

Risk Case	Baseline		8.1 million tpy		NGS at Proposed KMC (3-Unit)		Other Cumulative Sources		Total Cumulative Action	
	Cancer Risk[1]	Hazard Index[2]	Cancer Risk[1]	Hazard Index[2]	Cancer Risk[1]	Hazard Index[2]	Cancer Risk[1]	Hazard Index[2]	Cancer Risk[1]	Hazard Index[2]
Resident	6E-06	0.9	2E-06	0.02	3E-08	0.005	6E-11	0.0001	8E-06	0.9
Resident - Gardener	9E-06	1.1[3]	2E-06	0.02	3E-08	0.005	6E-11	0.0001	1E-05	1.1[3]
Resident- Farm Family	2E-05	1.9[4]	2E-06	0.02	3E-08	0.005	6E-11	0.0001	2E-05	1.9[4]

[1] Cancer risk estimates within or less than the USEPA cancer risk range (1 x 10^{-4} to 1 x 10^{-6}) are considered acceptable and require no further evaluation.

[2] HIs less than the target HI of 1 are considered acceptable and require no further evaluation.

[3] A HI of 1.1 for the resident gardener child exceeded the target HI of 1 and required further evaluation consisting of a target organ analysis. The target organ analysis revealed HIs less than 1 for all target organs, indicating acceptable noncancer risk and requiring no further evaluation.

[4] A HI of 1.9 exceeded the target HI of 1 and required further evaluation consisting of a target organ evaluation. Because the target organ evaluation for the resident farmer child exposure scenario demonstrated all target organ HQs and HIs were acceptable, a similar evaluation was not performed for any other scenarios or receptors.

3.16.5.3.4.2 Public Health

No cumulative impacts resulting in negative effects on public health associated the Proposed Action at the NGS are anticipated under either the 3-Unit Operation or 2-Unit Operation. However, over the 40 years of mining at proposed KMC, a number of factors have already impacted the public health of the local community (i.e., those living near or within the mine area boundaries). The public health evaluation concluded that a number of factors associated with mining operations lead to effects on the overall well-being and health, as well as quality of life of the affected population. Continued operation of the mine leads to cumulative impacts on the overall well-being and quality of life. Specifically:

- Within the history of the mine, an estimated 40 households have been relocated or compensated for their residences. Some relocated and compensated residents stayed within the lease area, others have moved to other locations. Continued operation of the mine under the Proposed Action leads to additional residents that will be relocated.
- A number of grazing areas have already been withdrawn over the 40-year operation of the mine. While reclamation has returned a number of those grazing areas to pre-mining conditions (or even improved conditions compared to pre-mining conditions), a number of community members have expressed concern that their withdrawn customary use areas may not be returned to them after reclamation is completed and the land is returned to the Navajo Nation. Note that the Navajo Nation in coordination with OSMRE, not PWCC, determines how reclaimed land is used (PWCC 2012 et seq.). Thus there is concern among some community members that loss of grazing areas will be permanent. Continued operation of the mine under the Proposed Action would lead to additional grazing lands being withdrawn and additional compensation to the affected residents.
- A number of community members have expressed concern over the loss of cultural resources associated with previous mining operations or past relocations (i.e., loss of burial grounds or disturbance of traditional landscape). While plans are in place to control and mitigate potential future losses to cultural resources, the historical losses are still affecting some of the community members, leading to a cumulative impact on the overall well-being, as well as quality of life of the affected population.

The public health evaluation of the Proposed Action noted the opposition to continued mining among some proposed KMC area residents. Whether the community concerns are related to direct health effects associated with mine operations (regardless of what the data indicate) or indirect effects such as visual disturbances, loss of traditional and cultural lifestyles, public safety related to nearby mining operations (see further details in Sections 1.9 and 1.10), the opposition to the Proposed Action could potentially cause emotional stress, leading to an impact on overall well-being and/or psychosocial health. A number of the people interviewed talked about being depressed because they had coexisted with mining effects and health issues for decades and now they are faced with the possibility of coexisting with mining for another 25 years. Thus, the continued opposition to the mine, could lead to cumulative impacts on the overall well-being and quality of life of the affected population.

In contrast, many community members support the continued operation of the mine. As discussed in Section 3.18, the mine has brought economic, employment and fiscal benefits to the local community, which leads to an improved quality of life. Those benefits take on added importance given the persistent high unemployment and poverty among the Navajo. Therefore, overall the continued operation of the NGS and proposed KMC also could result in positive cumulative impacts on overall well-being and quality of life due to the economic benefits associated with the proposed action.

3.16.5.4 Natural Gas Partial Federal Replacement Alternative

This discussion is divided into two parts. The first part describes the alternative site and operational characteristics, and primary human health and public health impacts that have occurred, or would occur.

The second part addresses the impacts to human health and public health from reducing the power generated at NGS, with consequent reductions in coal production at the Kayenta Mine.

Under the Natural Gas PFR Alternative, a selected quantity of power between 100 MW and 250 MW would be contracted for under a long-term power purchase agreement from currently unidentified, existing natural gas generation sources, displacing an equivalent amount of power from the federal share of NGS generation. Because the facility is assumed to currently exist, prior disturbance impacts to human health and public health resources are not evaluated. A key assumption about human health and public health resources related to such an existing site is listed below.

- Natural gas combustion to generate power would not result in deposition to soil of the trace metal associated with coal combustion under the Proposed Action. The difference in emissions is addressed in Section 3.1.

Impact issues for this PFR alternative are discussed across the range of NGS unit operations (3-Unit and 2-Unit) and associated alternative power reductions (100 MW and 250 MW) from the least NGS power reduction to the greatest. Reductions in NGS power generation would proportionally reduce the quantity of coal delivered from the Kayenta Mine.

The focus of this discussion is to distinguish differences in impacts within the replacement alternative operational range to provide a basis for comparison with the Proposed Action.

3.16.5.4.1 Navajo Generating Station

The following discusses the impacts to human health and public health if 100 MW to 250 MW of power generation were replaced at NGS by alternative power purchased from an unknown, but existing source of power from natural gas. As the alternative site is assumed to be an existing facility, prior disturbance impacts to human health and public health are not evaluated. At the NGS, the following relevant human health and public health impact topics are potentially affected by Natural Gas PFR alternative compared to the Proposed Action.

- Human exposures to airborne pollutants contained in stack emissions, and to pollutants deposited to the soil surface.
- Local employment opportunities to support NGS operations.

The NGS HHRA evaluated the human health impacts of the Natural Gas PFR. Potential cancer and noncancer risks to all receptors at NGS (Off-site Resident, Off-site Resident Gardener, Off-site Resident-Farm Family, Recreational Use, Off-site Commercial Worker) were less than USEPA benchmarks and considered acceptable under the Proposed Action NGS 3-Unit Operation and 2-Unit Operation risk scenarios. NGS emissions under this PFR would be approximately 5 percent (100-MW reduction) and 13 percent (250-MW reduction) less for than those estimated for the NGS 3-Unit Operation typical output. NGS emissions under this PFR would be approximately 8 percent (100-MW reduction) and 19 percent (250-MW reduction) less than those estimated for the NGS 2-Unit Operation typical output. As a consequence, human air and soil pollutant exposure would be proportionately reduced and potential cancer and noncancer risk estimates for all receptors at NGS under the Natural Gas PFR also would be considered acceptable and have a negligible impact on human health.

Particulate emissions under the Natural Gas PFR Alternative would be proportionally lower than those reported under the Proposed Action scenarios. Thus, $PM_{2.5}$ concentrations would meet NAAQS criteria, and NGS Operations under the Natural Gas PFR will have little to no effects on the health of the general population. Although NGS emissions would be reduced under the Natural Gas PFR, because it is not clear whether there is a threshold $PM_{2.5}$ concentration below which adverse health effects are not seen and due to the uncertainty regarding associations between long-term and short-term exposure and adverse health effects, sensitive subpopulations could still potentially experience some minor impacts such as exacerbation of existing health conditions, but the likelihood of the impact is even lower for the Natural Gas PFR than for the Proposed Action scenarios.

As discussed in Section 3.18, under the Natural Gas PFR Alternative, net reductions in jobs, labor income, tax revenues and other economic effects as compared to Proposed Action would occur. One of the major health impacts associated with the Proposed Action was positive impacts due to the socioeconomic benefits associated with increased revenue and continued and future employment opportunities at NGS. Implementation of the Natural Gas PFR Alternative would reduce the impact of those positive impacts.

3.16.5.4.2 Proposed Kayenta Mine Complex

The following discusses the impacts to human health and public health resources if 100 MW to 250 MW of power generation were replaced at NGS by alternative sources and the proposed KMC would mine less coal 8.1 million tpy production (NGS 3-Unit Operation) and 5.5 million tpy production (NGS 2-Unit Operation). Under the Natural Gas PFR, alternative power would be purchased by Reclamation from an unknown, but existing source. As the alternative site is assumed to be an existing facility, prior disturbance impacts to human health and public health are not evaluated. At the proposed KMC, the following relevant human health and public health impact topics are potentially affected by the Natural Gas PFR Alternative compared to the Proposed Action.

- Human exposure to airborne pollutants contained in fugitive dust, and to pollutants deposited to the soil surface.
- Local employment opportunities at proposed KMC to support NGS coal demands.
- Relocation of residents residing within the mining zones.
- Noise disturbances associated with mining.
- Loss of livestock grazing areas and cultural resources.

Potential cancer and noncancer risks to all receptors at proposed KMC (Off-site Resident, Off-site Resident Gardener, Off-site Resident-Farm Family) were less than USEPA benchmarks and considered acceptable under the Proposed Action proposed KMC 8.1 million tpy and 5.5 million tpy risk scenarios. Proposed KMC coal production under the Natural Gas PFR would be approximately 5 percent (100-MW reduction) and 12 percent (250-MW reduction) less for than those estimated for the proposed KMC 8.1 million tpy Proposed Action scenario. Proposed KMC coal production under the Natural Gas PFR would be approximately 7 percent (100-MW reduction) and 18 percent (250-MW reduction) less than those estimated for the proposed KMC 5.5 million tpy Proposed Action scenario. As a consequence, human air and soil pollutant exposure would be proportionately reduced and potential cancer and noncancer risk estimates for all receptors at the proposed KMC under the Natural Gas PFR Alternative also would be considered acceptable and have a negligible impact on human health.

Particulate emissions under the Natural Gas PFR would be proportionally lower than those reported under the Proposed Action scenarios. Thus, $PM_{2.5}$ concentrations would meet NAAQS criteria, and proposed KMC Operations under the Natural Gas PFR will have little to no effects on the health of the general population. Although proposed KMC emissions would be reduced under the Natural Gas PFR, because it is not clear whether there is a threshold $PM_{2.5}$ concentration below which adverse health effects are not seen and due to the uncertainty regarding associations between long-term and short-term exposure and adverse health effects, sensitive subpopulations could still potentially experience some minor impacts such as exacerbation of existing health conditions, but the likelihood of the impact is even lower for the Natural Gas PFR than for the Proposed Action scenarios.

As discussed in Section 3.18, under the Natural Gas PFR, net reductions in jobs, labor income, tax revenues and other economic effects as compared to Proposed Action would occur. One of the major health impacts associated with the Proposed Action was positive impacts due to the socioeconomic benefits associated with increased revenue and continued and future employment opportunities at NGS. Implementation of the Natural Gas PFR would reduce the demand of coal from the proposed KMC, particularly under the 2-Unit Operation scenario (44 percent of the coal needs would be required compared to the existing coal demands). One of the major health impacts associated with the Proposed Action was positive impacts due to the socioeconomic benefits associated with increased revenue and continued and future employment opportunities at proposed KMC. Implementation of the Natural Gas PFR would reduce the impact of those positive impacts. Thus, staffing reductions at proposed KMC and the associated reduction in beneficial health impacts associated with improved socioeconomics would be a likely outcome of the Natural Gas PFR. However, the reduced demand on coal to support the NGS operations under the Natural Gas PFR would lead to direct reductions in the number of residences affected (through emotional stress related to relocation, noise and vibration nuisances, and/or loss of grazing areas or cultural resources) by mining and blasting operations, particularly under the 2-Unit Operation scenario.

3.16.5.4.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

3.16.5.4.4 Project Impact Summary – All Project Components

The impacts to human health from NGS, proposed KMC, and transmissions lines and communication sites under the Natural Gas PFR would be negligible because potential cancer and noncancer risks to NGS and proposed KMC receptors would be less than USEPA benchmarks and considered acceptable. The potential public health benefits could be reduced based on the direct effects to the socioeconomic conditions of the affected community.

3.16.5.4.5 Cumulative Impacts

The public health evaluation and the HHRA conclusions consider the cumulative effects associated with existing conditions and the additional potential future impacts associated with the Natural Gas PFR. The same cumulative impacts on public health noted under the Proposed Action are anticipated under the Natural Gas PFR. Cumulative impacts to human health from baseline, the Natural Gas PFR and other cumulative sources would be low because all potential cancer and noncancer risks to NGS and proposed KMC receptors under these scenarios are less than USEPA benchmarks and considered acceptable, except for the unacceptable noncancer risk for the recreational user due to exposure to methyl mercury in fish. The number of potentially affected residents living within the mine zone requiring relocation would be reduced, particularly under 2-Unit Operation scenario; however, health impacts would still be moderate for the few residents that would be affected. Socioeconomic benefits associated with the Natural Gas PFR would be reduced compared to the Proposed Action, but would still result in better socioeconomic conditions than the No Action Alternative (see Section 3.18).

3.16.5.5 Renewable Partial Federal Replacement Alternative

3.16.5.5.1 Navajo Generating Station

Under the Renewable PFR Alternative, a selected quantity of power between 100 MW and 250 MW would be contracted for under a long-term power purchase agreement from a currently unidentified, existing renewable energy power source, displacing an equivalent amount of power from the federal share of NGS generation. As the site is assumed to be an existing facility, prior disturbance impacts to human health and public health are not evaluated. At the NGS, the following relevant human health and public health impact topics are potentially affected by the Renewable PFR Alternative compared to the Proposed Action.

- Human exposures to airborne pollutants contained in stack emissions, and to pollutants deposited to the soil surface.
- Local employment opportunities to support NGS operations.

Potential cancer and noncancer risks to all receptors at NGS (Off-site Resident, Off-site Resident Gardener, Off-site Resident-Farm Family, Recreational Use, Off-site Commercial Worker) were less than USEPA benchmarks and considered acceptable under the Proposed Action NGS 3-Unit Operation and 2-Unit Operation risk scenarios. NGS emissions under the Renewable PFR would be approximately 3 percent (100-MW reduction) and 7 percent (250-MW reduction) less for than those estimated for the NGS 3-Unit Operation typical output. NGS emissions under the Renewable PFR would be approximately 4 percent (100-MW reduction) and 11 percent (250-MW reduction) less than those estimated for the NGS 2-Unit Operation typical output. As a consequence, human air and soil pollutant exposure would be proportionately reduced and potential cancer and noncancer risk estimates for all receptors at NGS under the Renewable PFR Alternative also would be considered acceptable and have a negligible impact on human health.

Particulate emissions under the Renewable PFR would be proportionally lower than those reported under the Proposed Action scenarios. Thus, $PM_{2.5}$ concentrations would meet NAAQS criteria, and NGS Operations under the Renewable PFR Alternative will have little to no effects on the health of the general population. Although NGS emissions would be reduced under the Renewable PFR Alternative, because it is not clear whether there is a threshold $PM_{2.5}$ concentration below which adverse health effects are not seen and due to the uncertainty regarding associations between long-term and short-term exposure and adverse health effects, sensitive subpopulations could still potentially experience some minor impacts such as exacerbation of existing health conditions, but the likelihood of the impact is even lower for the Renewable PFR Alternative than for the Proposed Action.

As discussed in Section 3.18, under the Renewable PFR Alternative, net reductions in jobs, labor income, tax revenues and other economic effects as compared to Proposed Action would occur. One of the major health impacts associated with the Proposed Action was positive impacts due to the socioeconomic benefits associated with increased revenue and continued and future employment opportunities at NGS. Implementation of the Renewable PFR Alternative would reduce the impact of those positive impacts.

3.16.5.5.2 Proposed Kayenta Mine Complex

Under the Renewable PFR, alternative power would be purchased by Reclamation from an unknown, but existing source. Therefore, coal demand from proposed KMC would be reduced. As the alternative site is assumed to be an existing facility, prior disturbance impacts to human health and public health are not evaluated. At the proposed KMC, the following relevant human health and public health impact topics are potentially affected by the Renewable PFR Alternative compared to the Proposed Action.

- Human exposure to airborne pollutants contained in fugitive dust, and to pollutants deposited to the soil surface
- Local employment opportunities at proposed KMC to support NGS coal demands
- Relocation of residents residing within the mining zones
- Noise disturbances associated with mining
- Loss of livestock grazing areas and cultural resources

Potential cancer and noncancer risks to all receptors at proposed KMC (Resident, Resident Gardener, Resident-Farmer) were less than USEPA benchmarks and considered acceptable under the Proposed Action KMC 8.1 million tpy and 5.5 million tpy risk scenarios. Proposed KMC coal production under the Renewable PFR would be approximately 3 percent (100-MW reduction) and 7 percent (250-MW reduction) less for than those estimated for the proposed KMC 8.1 million tpy Proposed Action scenario. Proposed KMC coal production under the Renewable PFR would be approximately 4 percent (100-MW reduction) and 11 percent (250-MW reduction) less than those estimated for the proposed KMC 5.5 million tpy Proposed Action scenario. As a consequence, human air and soil pollutant exposure would be proportionately reduced and potential cancer and noncancer risk estimates for all receptors at proposed KMC under the Renewable PFR also would be considered acceptable and have a negligible impact on human health.

Particulate emissions under the Renewable PFR would be proportionally lower than those reported under the Proposed Action scenarios. Thus, $PM_{2.5}$ concentrations would meet NAAQS criteria, and proposed KMC Operations under the Renewable PFR will have little to no effects on the health of the general population. Although proposed KMC emissions would be reduced under the Renewable PFR, because it is not clear whether there is a threshold $PM_{2.5}$ concentration below which adverse health effects are not seen and due to the uncertainty regarding associations between long-term and short-term exposure and adverse health effects, sensitive subpopulations could still potentially experience some minor impacts such as exacerbation of existing health conditions, but the likelihood of the impact is even lower for the Renewable PFR than for the Proposed Action scenarios.

As discussed in Section 3.18, under the Renewable PFR, net reductions in jobs, labor income, tax revenues and other economic effects as compared to Proposed Action would occur. One of the major health impacts associated with the Proposed Action was positive impacts due to the socioeconomic benefits associated with increased revenue and continued and future employment opportunities at the proposed KMC. Implementation of the Renewable PFR would reduce the demand of coal from the proposed KMC, particularly under the 2-Unit Operation scenario (44 percent of the coal needs would be required compared to the existing coal demands). Thus, staffing reductions at the proposed KMC and the associated reduction in beneficial health impacts associated with improved socioeconomics would be a likely outcome of the Renewable PFR. However, the reduced demand on coal to support the NGS operations under the Renewable PFR would lead to direct reductions in the number of residences affected (through emotional stress related to relocation, noise and vibration nuisances, and/or loss of grazing areas or cultural resources) by mining and blasting operations, particularly under the 2-Unit Operation scenario.

3.16.5.5.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

3.16.5.5.4 Project Impact Summary – All Project Components

The impacts to human health from NGS, proposed KMC, and transmissions lines and communication sites under the Renewable PFR would be negligible because potential cancer and noncancer risks to NGS and proposed KMC receptors would be less than USEPA benchmarks and considered acceptable. The potential public health benefits could be reduced based on the direct effects to the socioeconomic conditions of the affected community.

3.16.5.5.5 Cumulative Impacts

The public health evaluation and the HHRA conclusions consider the cumulative effects associated with existing conditions and the additional potential future impacts associated with the Renewable PFR. The same cumulative impacts on public health noted under the Proposed Action are anticipated under the Renewable PFR. Cumulative impacts to human health from baseline, the Renewable PFR and other cumulative sources would be low because potential cancer and noncancer risks to NGS and proposed KMC receptors under these scenarios are less than USEPA benchmarks and considered acceptable, except for the unacceptable noncancer risk for the recreational user due to exposure to methyl mercury in fish. The number of potentially affected residents living within or in close proximity to an active mine zone requiring relocation would be reduced, particularly under 2-Unit Operation scenario; however, public health impacts would still be moderate for the few residents that would be affected. Socioeconomic benefits associated with the Renewable PFR would be reduced compared to the Proposed Action, but would still result in better socioeconomic conditions than the No Action Alternative.

3.16.5.6 Tribal Partial Federal Replacement Alternative

3.16.5.6.1 Navajo Generating Station

Under the Tribal PFR Alternative, between 100 MW and 250 MW of power generation from the NGS would be replaced by power supplied by a new photovoltaic generation facility on tribal land, displacing an equivalent amount of power from the federal share of NGS generation. The construction of a new photovoltaic generation site on tribal land would result in between 1,200 and 3,000 acres of new surface disturbance. The Tribal PFR facility would be analyzed in a separate NEPA process once a facility location is identified. Relevant human health and public health impacts topics are potentially affected by the Tribal PFR Alternative compared to the Proposed Action as listed below.

- Human exposures to airborne pollutants contained in stack emissions, and to pollutants deposited to the soil surface.
- Human exposures to emissions from natural gas electrical generation to provide firming (addressed in Section 3.1).
- Local employment opportunities to support NGS operations.

Potential cancer and noncancer risks to all receptors at NGS (Off-site Resident, Off-site Resident Gardener, Off-site Resident-Farm Family, Recreational Use, Off-site Commercial Worker) were less than USEPA benchmarks and considered acceptable under the Proposed Action NGS 3-Unit Operation and 2-Unit Operation risk scenarios. NGS emissions under the Tribal PFR would be approximately 2 percent (100-MW reduction) and 5 percent (250-MW reduction) less for than those estimated for the NGS 3-Unit Operation typical output. NGS emissions under the Tribal PFR would be approximately 3 percent (100-MW reduction) and 8 percent (250-MW reduction) less than those estimated for the NGS 2-Unit Operation typical output. As a consequence, human air and soil pollutant exposure would be proportionately reduced and potential cancer and noncancer risk estimates for all receptors at NGS under the Tribal PFR also would be considered acceptable and have a negligible impact on human health.

Particulate emissions under the Tribal PFR would be proportionally lower than those reported under the Proposed Action scenarios. Thus, $PM_{2.5}$ concentrations would meet NAAQS criteria, and proposed KMC Operations under the Tribal PFR will have little to no effects on the health of the general population. Although proposed KMC emissions would be reduced under the Tribal PFR, because it is not clear whether there is a threshold $PM_{2.5}$ concentration below which adverse health effects are not seen and due to the uncertainty regarding associations between long-term and short-term exposure and adverse health effects, sensitive subpopulations could still potentially experience some minor impacts such as exacerbation of existing health conditions, but the likelihood of the impact is even lower for the Tribal PFR Alternative than for the Proposed Action.

One of the major health impacts associated with the Proposed Action was positive impacts due to the socioeconomic benefits associated with increased revenue and continued and future employment opportunities at NGS.As discussed in Section 3.18, the Tribal PFR Alternative would result in a combination of temporary construction and long-term operating jobs in conjunction with the photovoltaic solar project. Overall, the net differences in employment and revenue would be slightly less favorable for the Tribal PFR compared to the Proposed Action, but would still result in better socioeconomic conditions than the No Action Alternative.

3.16.5.6.2 Proposed Kayenta Mine Complex

The following discusses the impacts to human health and public health if 100 MW to 250 MW of power generation were replaced at NGS by alternative sources purchased by Reclamation from a new photovoltaic generation site on tribal land. The construction of a new photovoltaic generation site on tribal land would require the commitment of land, and would result in new surface disturbance at a location that would be evaluated in a subsequent NEPA action. Coal demand from proposed KMC would be reduced. At the proposed KMC, the following relevant human health and public health impact topics are potentially affected by Tribal PFR Alternative compared to the Proposed Action.

- Human exposure to airborne pollutants contained in fugitive dust, and to pollutants deposited to the soil surface.
- Local employment opportunities at proposed KMC to support NGS coal demands.
- Relocation of residents residing within the mining zones.
- Noise disturbances associated with mining.
- Loss of livestock grazing areas and cultural resources.

Potential cancer and noncancer risks to all receptors at proposed KMC (Resident, Resident Gardener, Resident-Farmer) were less than USEPA benchmarks and considered acceptable under the Proposed Action proposed KMC 8.1 million tpy and 5.5 million tpy risk scenarios. Proposed KMC coal production under the Tribal PFR would be approximately 2 percent (100-MW reduction) and 5 percent (250-MW reduction) less for than those estimated for the proposed KMC 8.1 million tpy Proposed Action scenario. Proposed KMC coal production under the Tribal PFR would be approximately 3 percent (100-MW reduction) and 7 percent (250-MW reduction) less than those estimated for the proposed KMC 5.5 Proposed Action scenario. As a consequence, human air and soil pollutant exposure would be proportionately reduced and potential cancer and noncancer risk estimates for all receptors at proposed KMC under the Tribal PFR also would be considered acceptable and have a negligible impact on human health.

Particulate emissions under the Tribal PFR would be proportionally lower than those reported under the Proposed Action scenarios. Thus, $PM_{2.5}$ concentrations would meet NAAQS criteria, and proposed KMC Operations under the Tribal PFR will have little to no effects on the health of the general population. Although proposed KMC emissions would be reduced under the Tribal PFR, because it is not clear whether there is a threshold $PM_{2.5}$ concentration below which adverse health effects are not seen and due to the uncertainty regarding associations between long-term and short-term exposure and adverse health effects, sensitive subpopulations could still potentially experience some minor impacts such as exacerbation of existing health conditions, but the likelihood of the impact is even lower for the Tribal PFR than for the Proposed Action scenarios.

As discussed in Section 3.18, under the Tribal PFR, net reductions in jobs, labor income, tax revenues and other economic effects as compared to Proposed Action could be potentially off-set by the increase in revenue associated with the new land lease to support the new solar project. In addition, the reduced demand on coal to support the NGS operations under the Tribal PFR would lead to direct reductions in the number of residences effected (through emotional stress related to relocation, noise and vibration nuisances, and/or loss of grazing areas or cultural resources) by mining and blasting operations, particularly under the 2-Unit Operation scenario.

3.16.5.6.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

Additional disturbance could occur to an unknown number of acres related to connecting a new photovoltaic generation site on tribal land to the existing transmission system and would be evaluated in a subsequent NEPA action.

3.16.5.6.4 Project Impact Summary – All Project Components

The impacts to human health from NGS, proposed KMC, and transmissions lines and communication sites under the Tribal PFR would be negligible because potential cancer and noncancer risks to NGS and proposed KMC receptors would be less than USEPA benchmarks and considered acceptable. Compared to the Proposed Action, potential public health benefits under the Tribal PFR could be associated with reduced air pollutant emissions from NGS (yet continued operation of the plant through 2044), reduced impact to residents living on or near the mining zones (due to less coal demand), as well as the increased revenue associated with the new lease. While the NGS and proposed KMC would experience some reduction in labor requirements, leading to fewer job opportunities, the potential benefits could potentially offset this impact.

3.16.5.6.5 Cumulative Impacts

The public health evaluation and the HHRA conclusions consider the cumulative effects associated with existing conditions and the additional potential future impacts associated with the Tribal PFR. The same cumulative impacts on public health noted under the Proposed Action are anticipated under the Tribal PFR. Cumulative impacts to human health from baseline, the Tribal PFR and other cumulative sources would be low because potential cancer and noncancer risks to NGS and proposed KMC receptors under these scenarios are less than USEPA benchmarks and considered acceptable, except for the unacceptable noncancer risk for the recreational user due to exposure to methyl mercury in fish. The number of potentially affected residents living within the mine zone requiring relocation would be reduced, particularly under 2-Unit Operation scenario; however, health impacts would still be moderate for the few residents that would be affected. Socioeconomic benefits associated with the Tribal PFR would be reduced compared to the Proposed Action, but would still result in better socioeconomic conditions than the No Action alternative.

3.16.5.7 No Action

Under the No Action Alternative, required federal approvals to extend the operations of the plant beyond December 23, 2019, would not be obtained. Decommissioning activities would begin in 2018 with effective shutdown of the plant occurring by the end of 2019. Structures within the plant site would be demolished to ground level with the exception of those which are to remain in accordance with the lease agreement terms. Demolished structures largely would be buried in place or in on-site landfills.

NGS is the only consumer for the coal mined at the proposed KMC; therefore, if the NGS is not permitted beyond 2019, mining at the proposed KMC would cease once decommissioning is initiated at the NGS. Final reclamation would commence under an approved reclamation plan in accordance with Surface Mining Control and Reclamation Actand structures not approved as permanent facilities would be removed. Reclamation would likely resemble past reclamation and provide vegetation communities that offer forage for livestock grazing, in accordance with designated post-mining land use.

3.16.5.7.1 Navajo Generating Station

Under the No Action Alternative, the facilities would cease production in 2019 and demolition would occur starting in 2020. Immediately following cessation of operations, there may be site closure and remediation activities that would generate emissions (i.e., fugitive dust) and lead to nearby impacts. It is expected that such emissions and impacts would be in short duration and would be less than current emissions encountered at the site boundary due to standard construction best management practices implanted by Salt River Project Agricultural Improvement and Power District to minimize dust.

To determine the impacts from the No Action Alternative, the human health risks caused by emissions from other regional and global sources, i.e., other cumulative sources, impacts of mercury emissions from sources other than NGS and proposed KMC, including non-U.S. sources were characterized using mercury deposition data from the EPRI San Juan River Basin study (EPRI 2016). Impacts of arsenic and selenium emissions from the Four Corners Power Plant and San Juan Generating Station were characterized using data from the EPRI study. As presented in **Table 3.16-19**, HHRA results generated for the No Action Alternative (HHRA environmental baseline + other cumulative sources) predicted that the estimated excess lifetime cancer risks were within the USEPA acceptable cancer risk range of 1 x 10^{-4} to 1 x 10^{-6}. All noncancer HIs for the No Action Alternative were less than the benchmark of 1 with the exception of chronic HI for the recreational users which was 2 due to exposures to methyl mercury via fish consumption.

The NGS HHRA concluded that negligible impact on human health was identified based on the No Action scenario for all receptor pathways which were considered acceptable except the ingestion of fish by the recreational user. Based on an unacceptable noncancer hazard of 2 for the ingestion of fish by the recreational user, a low impact on human health was identified. The impact is considered minor because of the fish advisory (AGFD 2012) that likely limits the consumption of fish.

Table 3.16-19 NGS HHRA Results: Baseline and Other Cumulative Sources

Receptor	Baseline		Other Cumulative Sources		No Action (Baseline + Other Cumulative Sources)	
	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index
Resident	2E-06	0.1	3E-11	0.0006	2E-06	0.1
Resident-Gardener	5E-06	0.7	3E-11	0.002	5E-06	0.7
Resident-Farm Family	4E-05	0.8	3E-11	0.003	4E-05	0.8
Recreational User	4E-06	1	3E-13	1	4E-06	2
Commercial Worker	5E-07	0.02	8E-12	0.00006	5E-07	0.02

3.16.5.7.2 Proposed Kayenta Mine Complex

Under the No Action Alternative, the mine would cease operation and mined areas would be reclaimed. Temporary emissions would be associated primarily with reclamation activities over 3 to 5 years after mining ceases. It is expected that such emissions would be in short duration and would be considerable less than current emissions encountered at the site boundary due to best practices to minimize dust implanted by PWCC.

The No Action risk scenario evaluated potential risks at the proposed KMC from non-NGS and non-KMC regional and global sources, and are the same for both Proposed Action (8.1 million tpy and 5.5 million tpy) options. As presented in **Table 3.16-20**, the cancer risk estimates for the No Action Alternative are within the USEPA acceptable risk range. The chronic HIs for the No Action Alternative are attributed to the baseline and range from 0.9 for the child resident to 1.9 for the child resident farmer. Because the target organ evaluation for the resident farmer child exposure scenario demonstrated all target organ HQs and HIs were acceptable, no further action was required. Estimated other cumulative sources impacts on the potential for adverse cancer and noncancer health effects at the proposed KMC were negligible.

Table 3.16-20 Summary of Proposed KMC HHRA Results – Baseline and Other Cumulative Sources (No Action)

	Baseline		Other Cumulative Sources		Baseline + Other Cumulative Sources	
Risk Case	**Cancer Risk[1]**	**Hazard Index[2]**	**Cancer Risk[1]**	**Hazard Index[2]**	**Cancer Risk[1]**	**Hazard Index[2]**
Resident	6E-06	0.9	6E-11	0.0001	6E-06	0.9
Resident - Gardener	9E-06	1.1[3]	6E-11	0.0001	9E-06	1.1[3]
Resident-Farm Family	2E-05	1.9[4]	6E-11	0.0001	2E-05	1.9[4]

[1] Cancer risk estimates within or less than the USEPA cancer risk range (1 x 10^{-4} to 1 x 10^{-6}) are considered acceptable and require no further evaluation.

[2] HIs less than the target HI of 1 are considered acceptable and require no further evaluation.

[3] An HI of 1.1 for the resident gardener child exceeded the target HI of 1 and required further evaluation consisting of a target organ analysis. The target organ analysis revealed His less than 1 for all target organs, indicating acceptable noncancer risk and no further evaluation was required.

[4] A HI of 1.9 exceeded the target HI of 1 and required further evaluation consisting of a target organ evaluation. Because the target organ evaluation for the resident farmer child exposure scenario demonstrated all target organ HQs and HIs were acceptable, a similar evaluation was not performed for any other scenarios or receptors.

3.16.5.7.3 Transmission Systems and Communication Sites

The NGS transmission system is an established part of the western U.S. transmission grid and supports reliability and delivery of power throughout the region, well beyond the power generated by the NGS. Therefore, under the No Action Alternative it is likely that that one, several, or all of the land owners/managers of the transmission line rights-of-way and communication site leases would renew some portion of the facilities to keep the power grid performing as expected.

In the event it is determined that some or all of the transmission systems and communication site ROWs are not renewed, a lengthy study and permitting process would need to occur before any decommissioning is initiated due to the essential and integral nature of these facilities with the western electric grid. As noted in Section 2.3.3, up to 4,826 acres within and alongside the transmission system corridors could be temporarily disturbed if the entirety of the transmission systems and communication sites were decommissioned and removed.

3.16.5.7.4 Public Health

Under the No Action Alternative, all of the negative health impacts associated with the Proposed Action Alternative and identified on **Table 3.16-11** would be eliminated. Specifically, for the NGS, because it would no longer be operating, potential impacts to air quality would improve, reducing the potential for negative health impacts to sensitive subpopulations with existing health conditions that are exacerbated by exposure to increased levels of particulates. For proposed KMC, because mining operations would cease after 2019 under the No Action Alternative, the following negative health impacts would be eliminated:

- No additional relocation of residences would occur; eliminating the negative impact to overall well-being and psychosocial health resulting from the emotional stress associated with relocation;
- No blasting would occur, eliminating the negative impact to overall well-being and psychosocial health resulting from the stress induced by the nuisance and annoyance of blasting noise and vibration; and

- No loss of livestock grazing areas or cultural resources would occur; eliminating the negative impact to nutrition associated with loss of nutrition sources that livestock and culturally significant plants provide, the negative impact to well-being associated with the potential loss of income associated with change in livestock grazing areas, and the negative impact to well-being associated with the potential loss of cultural resources impacting traditional lifestyles and tribal cultures.

However, while all of the negative impacts associated with the Proposed Action would be eliminated under the No Action Alternative, the positive benefits on health associated with the improved socioeconomic conditions that the NGS and associated mining activities provides to the local community also would be eliminated. Because the NGS and the Kayenta Mine are economically interrelated in terms of impacts to employees, and revenues to the Navajo Nation and Hopi Tribe, the consequences of the No Action Alternative implementation are addressed for both components together. Specifically, as detailed in Section 3.18, socioeconomic effects that would result from the No Action Alternative would be major, widespread, long-lasting, and predominately adverse. These effects would directly and indirectly affect the Navajo and Hopi tribal governments, many households, businesses and local government agencies and services. Because the NGS and Kayenta Mine are among the largest private sector employers in northeastern Arizona, the effects would extend to Coconino, Navajo and Apache counties and throughout the state. The loss of jobs and income and the reductions in revenues paid to the tribes would be substantial adverse effects of the No Action Alternative, given persistently high unemployment and poverty among on-reservation Navajo and Hopi, and the importance of the revenues paid to the tribal governments in supporting tribal employment and the provision of services on a reservation wide basis.

The importance of the jobs, income and revenues is underscored by the lack of any currently identified or reasonably foreseeable new industrial or commercial development that offers prospects to offset the losses. These socioeconomic effects could have potentially dramatic indirect effects on health because general health and well-being are closely correlated to the socioeconomic conditions of the community (WHO 2008). In general, communities with low income potential and high unemployment have much poorer health statistics and reduced access to health care. In addition, with closure of the mine, the PWCC EMS clinic also would be closed, eliminating one of the already limited health care facilities in the area. The existing poor health rankings due in large part to lifestyle risk factors would remain and could potentially be exacerbated by the sudden economic impacts to the local community.

In addition, many community members support the continued operation of the NGS and supporting mining activities at proposed KMC. As discussed in Section 3.18, the mine has brought economic, employment and fiscal benefits to the local community, which leads to an improved quality of life. Implementation of the No Action Alternative could lead to emotional stress resulting from the uncertainties associated with potential loss of income, employment and health benefits. The emotional stress resulting from closure of NGS and proposed KMC mine also could potentially result in negative impacts to overall well-being, psychosocial health, and quality of life of the affected community.

3.16.5.7.5 No Action Impact Summary – All Project Components

The impacts to human health from NGS, proposed KMC, and transmissions lines and communication sites under the No Action Alternative would be low to moderate. Based on an unacceptable noncancer hazard of 2 for the ingestion of fish by the recreational user under the NGS No Action Alternative, a minor impact on human health was identified. The impact is considered minor because of the fish advisory (AGFD 2012) that likely limits the consumption of fish.

As discussed above, the socioeconomic and psychosocial effects (i.e., loss of jobs and income, reduction in revenue paid to the tribes, closure of PWCC EMS clinic) that would result from the No Action Alternative would be have a major impact on public health in the project study area.

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Section 3.17

Cultural Resources

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Acronyms and Abbreviations

1969 Lease	Navajo Project Indenture of Lease
ARPA	Archaeological Resource Protection Act
BART	Best Available Retrofit Technology
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BM&LP Railroad	Black Mesa & Lake Powell Railroad
BMAP	Black Mesa Archaeological Project
BO	Biological Opinion
CAP	Central Arizona Project
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CO_2	carbon dioxide
Co-tenants	Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
Development Fund	Lower Colorado River Basin Development Fund
DQAS	Data Quality Assessment Survey
EIS	Environmental Impact Statement
ERA	Ecological Risk Assessment
ESA	Endangered Species Act of 1973
HHRA	Human Health Risk Assessment
km	kilometer
KMC	Kayenta Mine Complex
kV	kilovolt
kW	kilowatt
MW	megawatt
N-Aquifer	Navajo Aquifer
NAGPRA	Native American Graves Protection and Repatriation Act of 1990
NEPA	National Environmental Policy Act of 1969, as amended
NGS	Navajo Generating Station
NGS Participants	U.S. (Reclamation), Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
NHPA	National Historic Preservation Act
NNEPA	Navajo Nation Environmental Protection Agency
NO_2	nitrogen dioxide
NO_X	nitrogen oxide
NRHP	National Register of Historic Places
O&M	Operation and maintenance
OSMRE	Office of Surface Mining Reclamation and Enforcement
PA	Programmatic Agreement
PM	particulate matter

PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 microns or less
PFR	Partial Federal Replacement
PWCC	Peabody Western Coal Company
Reclamation	Bureau of Reclamation
ROW	Right-of-way
SMCRA	Surface Mining Control and Reclamation Act of 1977
SO_2	sulfur dioxide
SRP	Salt River Project Agricultural Improvement and Power District
STS	Southern Transmission System
TCL	Traditional Cultural Landscape
TCP	Traditional Cultural Property
tpy	tons per year
U.S.	United States
USEPA	U.S. Environmental Protection Agency
WTS	Western Transmission System

Contents

3.17 Cultural Resources 3.17-1
3.17.1 Regulatory Framework 3.17-1
3.17.1.1 Development of Programmatic Agreements 3.17-7
3.17.2 Study Areas 3.17-10
3.17.2.1 Proposed Action and Action Alternatives 3.17-10
3.17.2.2 Cumulative 3.17-14
3.17.3 Affected Environment 3.17-14
3.17.3.1 Data Collection 3.17-14
3.17.3.2 Overview: Cultural History and Federally Recognized Tribes 3.17-17
3.17.3.3 Navajo Generating Station 3.17-24
3.17.3.4 Proposed Kayenta Mine Complex 3.17-27
3.17.3.5 Transmission Systems and Communication Sites 3.17-34
3.17.3.6 Summary 3.17-41
3.17.4 Environmental Consequences 3.17-42
3.17.4.1 Issues 3.17-42
3.17.4.2 Assumptions and Impact Methodology 3.17-43
3.17.4.3 Proposed Action 3.17-45
3.17.4.4 Natural Gas Partial Federal Replacement Alternative 3.17-51
3.17.4.5 Renewable Partial Federal Replacement Alternative 3.17-52
3.17.4.6 Tribal Partial Federal Replacement Alternative 3.17-53
3.17.4.7 No Action 3.17-54
3.17.5 References 3.17-56

List of Tables

Table 3.17-1 Cultural Resource Laws, Regulations, Executive Orders, and Other Federal Authorities ... 3.17-2

Table 3.17-2 KMC Programmatic Agreement Consultation ... 3.17-8

Table 3.17-3 NGS Programmatic Agreement Consultation ... 3.17-8

Table 3.17-4 Affected Environment Lands within the Proposed KMC ... 3.17-13

Table 3.17-5 Repositories and Institutions Providing Data for the Cultural Resources Records Search and Literature Review ... 3.17-15

Table 3.17-6 Chronological Period of Archaeological Cultural Resources in the BM&LP Railroad Portion of the Study Area ... 3.17-25

Table 3.17-7 Archaeological Site Type of Archaeological Cultural Resources in the BM&LP Railroad Portion of the Study Area ... 3.17-26

Table 3.17-8 Status of Cultural Resources Sites on Former Black Mesa Mine and Kayenta Mine Permit Areas ... 3.17-29

Table 3.17-9 Data Quality Assessment Survey Results ... 3.17-31

Table 3.17-10 Archaeological Cultural Resources within Lands Affected by Prior Actions in the Proposed KMC ... 3.17-32

Table 3.17-11 Archaeological Cultural Resources within the Proposed KMC ... 3.17-32

Table 3.17-12 Known TCPs and Human Burials Within or Near Proposed KMC Mine Areas ... 3.17-34

Table 3.17-13 Archaeological Cultural Resources Along the Western Transmission System ... 3.17-35

Table 3.17-14 Chronological Period of Archaeological Cultural Resources Along the Western Transmission System ... 3.17-35

Table 3.17-15 Historic Properties Along the Western Transmission System ... 3.17-36

Table 3.17-16 Archaeological Cultural Resources Along the Southern Transmission System ... 3.17-38

Table 3.17-17 Existing and Potential TCPs near the Southern Transmission System ROW ... 3.17-39

Table 3.17-18 Locations of Previous Cultural Resources Investigations at External Communications Sites ... 3.17-39

Table 3.17-19 Archaeological Cultural Resources at External Communication Sites ... 3.17-40

Table 3.17-20 Existing and Potential TCPs at or Near External Communication Sites ... 3.17-41

Table 3.17-21 Status of Archaeological Cultural Resources by Project Feature ... 3.17-42

Table 3.17-22 Impact Issues Anticipated on the Proposed KMC ... 3.17-43

Table 3.17-23 Definitions of Impact Magnitude Determinations for Cultural Resources ... 3.17-44

Table 3.17-24 Eligible Cultural Resources Potentially Affected by the Proposed Action 8.1 Million tpy Operation ... 3.17-46

Table 3.17-25 Eligible and Potentially Eligible Cultural Resources Potentially Affected by the Proposed Action 5.5 Million tpy Operation 3.17-47

Table 3.17-26 Proposed Action Impact Summary to Historic Properties and TCPs 3.17-49

Table 3.17-27 Cumulative Impacts to Cultural Resources 3.17-50

List of Figures

Figure 3.17-1 Cultural Resources Project Overview 3.17-11

Figure 3.17-2 Proposed KMC Areas of Potential Effects 3.17-12

Figure 3.17-3 Cultural Environmental Areas 3.17-18

Figure 3.17-4 Proposed KMC – Kayenta Mine and Former Black Mesa Mine 3.17-28

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3.17 Cultural Resources

Cultural resources is the term used by practitioners in the identification, evaluation, and treatment of tangible locations of human activity, occupation, or use that have been identified through field inventory (survey), historical documents, or oral evidence. Cultural resources include archaeological sites and districts, historical architectural resources (buildings, structures, and districts), and places of religious and cultural significance (including sacred sites) to cultural groups, including Indian Tribes. Under Section 106 of the National Historic Preservation Act (NHPA) and its implementing regulations at 36 Code of Federal Regulations (CFR) Part 800, federal agencies are required to consider the effects of their undertaking on cultural resources that are listed in or eligible for listing in the National Register of Historic Places (NRHP). These resources that are listed in or eligible for listing in the NRHP are defined in regulation as historic properties.

3.17.1 Regulatory Framework

Federal historic preservation legislation provides a legal framework for documentation, evaluation, and protection of cultural resources that may be affected by federal undertakings. The following laws and regulations are relevant to the Navajo Generating Station (NGS)-proposed Kayenta Mine Complex (KMC) Project.

Historic properties are districts, sites, buildings, structures, and objects significant in American history, architecture, archaeology, engineering, and culture that are listed in or eligible for listing in the NRHP. The term historic property includes properties of religious and cultural significance to an Indian Tribe that meet the NRHP criteria. These places of religious and cultural significance are usually referred to as Traditional Cultural Properties (TCPs). Federal agencies also must afford the Advisory Council on Historic Preservation a reasonable opportunity to comment on the undertaking.

36 CFR Part 800 is the Advisory Council on Historic Preservation's regulation implementing Section 106 of the NHPA. Part B of the regulation (36 CFR Part 800.3-800.6) establishes a process through which historic properties are identified, as follows:

- Initiate the Section 106 process by establishing the undertaking and consulting with the appropriate parties, including federal agencies, State Historic Preservation Offices, Tribal Historic Preservation Offices, Indian tribes, local governments, and the public.
- Identify historic properties within the Area of Potential Effects through inventory and evaluation of their historic significance by applying the NRHP criteria. See 36 CFR Part 60.4 for National Register criteria, National Register Bulletin 15 for the process of determining if a property is eligible for listing in the NRHP, and National Register Bulletin 38 for evaluating and documenting TCPs.
- Assess whether there would be effects to historic properties in the Area of Potential Effects by applying the criteria of effects.
- If effects would occur, take appropriate steps to resolve those effects.

Of particular importance to the NGS-KMC Project is the requirement set forth in 36 CFR Part 800 (and a 1992 amendment to the NHPA) that a federal agency must consult with Indian tribes concerning properties of religious and cultural significance to them that may be eligible for listing in the NRHP. National Register Bulletin 38 (Parker and King 1990) defines a TCP as one that is eligible for inclusion in the NRHP because of its association with cultural practices or beliefs of a living community that: (1) is rooted in that community's history; and (2) is important in maintaining the continuing cultural identity of the community. American Indian consultation includes identification of tangible properties of traditional cultural importance that include, but are not limited to, physical locations associated with the traditional beliefs concerning tribal origins, cultural history, or the nature of the world; locations where religious practitioners go, either in the past or present, to perform ceremonial activities based on traditional cultural rules or practice; ancestral habitation sites; trails; burial sites; and places from which plants, animals, minerals, and water possessing healing powers or used for other subsistence purposes may be taken. Some of these locations may be considered sacred to particular Native American individuals or tribal communities.

In addition to NHPA Section 106 requirements, federal agencies must meet the requirements of several additional laws, regulations, executive orders, and other federal authorities. Among these are the Archaeological Resource Protection Act (ARPA) of 1979; Native American Graves Protection and Repatriation Act of 1990 (NAGPRA); Surface Mining Control and Reclamation Act of 1977 (SMCRA); National Trails System Act of 1968; Secretarial Order No. 3175: Departmental Responsibilities for Indian Trust Resources; Executive Order 13007: Indian Sacred Sites; and Executive Order 13175: Consultation and Coordination with Indian Tribal Governments. For the NGS-KMC Project, the United States (U.S.) Bureau of Reclamation (Reclamation) also must acknowledge the jurisdiction of the Navajo Nation Cultural Resources Protection Act on surface lands controlled by the Navajo Nation and the jurisdiction of Hopi Ordinance 26: Ordinance for the Protection of Places and Objects of Sacred, Historical and Scientific Interest on the Hopi Reservation. In addition, Reclamation must adhere to state burial laws should human remains and associated funerary items be discovered on state lands as a result of its actions. A summary of these laws, regulations, executive orders, and other federal authorities is presented in **Table 3.17-1**.

Table 3.17-1 Cultural Resource Laws, Regulations, Executive Orders, and Other Federal Authorities

Regulation	Summary
National Historic Preservation Act of 1966, as amended (Public Law 89-665; formerly 16 U.S. Code Section 470 et seq., as amended, currently 54 U.S. Code Section 300101) Section 106 implementing regulations are at 36 CFR Part 800. 36 CFR Part 60 NRHP lists the criteria for eligibility.	Section 106 of NHPA requires federal agencies to take into account the effect of its undertaking on historic properties. Historic properties are districts, sites, buildings, structures, and objects significant in American history, architecture, archaeology, engineering, and culture that are listed in or eligible for listing in the NRHP. The term historic property includes properties of religious and cultural significance to an Indian Tribe (also known as TCPs) that meet NRHP criteria. Federal agencies also must afford the Advisory Council on Historic Preservation a reasonable opportunity to comment on the undertaking. To be considered for inclusion in the National Register, properties must be at least 50 years old (unless they have exceptional significance) and possess integrity of location, design, setting, feeling, materials, workmanship, and association. To be eligible, properties must meet one or more of the following criteria to demonstrate their significance in American history, architecture, archaeology, engineering, or culture: Criterion A: are associated with events that have made a significant contribution to the broad patterns of our history; Criterion B: are associated with the lives of persons significant in our past; Criterion C: embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; Criterion D: have yielded, or may be likely to yield, information important in prehistory or history.

Table 3.17-1 Cultural Resource Laws, Regulations, Executive Orders, and Other Federal Authorities

Regulation	Summary
American Indian Religious Freedom Act, 1978; Public Law 95-341, 42 U.S. Code Section 1996 and 1996a (as amended).	American Indian Religious Freedom Act recognizes that religious practices of American Indians (as well as Native Alaskans and Native Hawaiians) form the basis of their cultural identity and value systems. American Indian Religious Freedom Act establishes a federal policy of protecting and preserving the inherent right of individual Native Americans to believe, express, and exercise their traditional religions including, but not limited to, access to sacred sites, use and possession of sacred objects, and the freedom to worship through ceremonials and traditional rites.
ARPA of 1979; Public Law 96-95, 16 U.S. Code Section 470aa-mm, as amended). Archaeological Resource Protection Act's implementing regulations are at 43 CFR Part 7.	ARPA acknowledges that archaeological resources on federal and American Indian land are an accessible and irreplaceable part of the Nation's heritage. ARPA requires that a permit be obtained from a federal land manager to excavate or remove any archaeological resource on U.S. public or Indian lands. Permits may be issued only to qualified educational or scientific institutions for the purpose of furthering archaeological knowledge in the public interest. Major penalties for violating this law include substantial fines and imprisonment.
Native American Graves Protection and Repatriation Act of 1990; Public Law 101-601, 25 U.S. Code Section 3001 et seq., as amended). The implementing regulations for NAGPRA are at 43 CFR Part 10.	NAGPRA establishes a means for culturally affiliated Indian tribes (and Native Hawaiian organizations) to request the return of human remains and associated funerary objects, as well as unassociated funerary objects, sacred objects, and objects of cultural patrimony, held by federal agencies or federally assisted museums or institutions. NAGPRA also contains provisions regarding the intentional excavation and removal, inadvertent discovery, and illegal trafficking of Native American human remains and sensitive cultural items.
Religious Freedom Restoration Act of 1993 (Religious Freedom Restoration Act; Public Law 103-141, 107 Stat. 1488, as amended).	The intent of Religious Freedom Restoration Act is to prevent enactment of federal laws that substantially burden an individual's free exercise of his or her religion. The law applies to Native American religious practitioners, as well as the wider U.S. public.
National Trails System Act of 1968 (Public Law 90-543 and PL. 111-11, 16 U.S. Code Section 1241–1251 (as amended).	National Trails System Act creates a series of national trails "to promote the preservation of, public access to, travel within, and enjoyment and appreciation of the open-air, outdoor areas and historic resources of the Nation." Specifically, the Act authorized three types of trails: national recreation trails, national scenic trails, national historic trails, and connecting or side trails to these three major classes of trail. Among these trails is the Old Spanish National Historic Trail, which intersects portions of the NGS-KMC Project area.
SMCRA; Public Law 95-87, 30 U.S. Code Section 1201 et seq. SMCRA's implementing regulations are at 30 CFR Part 750.	SMCRA establishes a nationwide program to protect society and the environment from the effects of surface coal mining operations. The Act also established the Office of Surface Mining Reclamation and Enforcement (OSMRE) to implement this law. Among its many provisions are 30 CFR Part 750.12 that addresses permit applications and the need for specific cultural resource information and 30 CFR Part 761.11 that address cemeteries (any area of land where human bodied are interred) as a type of area where mining is prohibited or limited.
Secretarial Order No. 3175: Departmental Responsibilities for Indian Trust Resources (November 8, 1993).	This order requires that all U.S. Department of the Interior bureaus and offices consult with the recognized tribal government with jurisdiction over the trust property potentially affected by a Proposed Action.

Table 3.17-1 Cultural Resource Laws, Regulations, Executive Orders, and Other Federal Authorities

Regulation	Summary
Executive Order 13007: Indian Sacred Sites (May 24, 1996).	Executive Order 13007 requires federal agencies to the extent practicable, permitted by law, and not clearly inconsistent with essential agency functions to: (1) accommodate access to and ceremonial use of Indian sacred sites by Indian religious practitioners; and (2) avoid effects to the physical integrity of sacred sites. It also requires federal agencies to develop procedures for reasonable notification of proposed actions or land management policies that may restrict access to, ceremonial use of, or effect to sacred sites. A sacred site may not meet the NRHP criteria for defining a historic property, but may indeed be considered a TCP by one or more tribes.
Executive Order 13175: Consultation and Coordination with Indian Tribal Governments (November 6, 2000).	Executive Order 13175 was issued to establish regular and meaningful consultation and collaboration with tribal officials in the development of federal policies that have tribal implications.
Hopi Ordinance 26: Ordinance for the Protection of Places and Objects of Sacred, Historical and Scientific Interest on the Hopi Reservation (November 5, 1974).	The purpose of this law is to protect sites, locations, structures, and objects of a sacred, historical, or scientific interest or nature on lands within the jurisdiction of the Hopi Tribe from desecration, destruction, theft, or other harm or interference. This Tribal Ordinance lists prohibited acts on any protected place or object (as defined in the ordinance) within the Hopi Reservation; provides penalties for violators; and requires approved licenses for qualified individuals or institutions with legitimate, specific, historical, and scientific research. In 1990, the Hopi Tribal government established the Hopi Cultural Preservation Office, under the division of the Department of Natural Resources. The Hopi Cultural Preservation Office is responsible for enforcement of Hopi Ordinance 26; it also conducts research, issues protocols for conducting research, and works closely with a group of cultural resource experts drawn from Hopi villages and religious societies to interpret and protect cultural knowledge.
Navajo Nation Cultural Resources Protection Act, 1988; CMY-19-88, Navajo Nation Code Title 19, Chapter 19, Chapter 11.	This law acknowledges the importance of preserving the cultural heritage of the Navajo Nation for the benefit of the Navajo People. It establishes as policy the use of appropriate measures to foster conditions under which modern Navajo society and its cultural resources can coexist in productive harmony to fulfill the social, economic, and other requirements of present and future generations. Navajo Nation Cultural Resources Protection Act establishes the following: (1) the Navajo Nation Historic Preservation Department within the Navajo Nation Division of Natural Resources serves as the agency responsible for the protection, preservation, and management planning for the Nation's cultural resources, directed by a Tribal Historic Preservation Officer (Tribal Historic Preservation Office); (2) the Navajo Nation Archaeology Department within the Navajo Nation Division of Natural Resources provides cultural resource services to project sponsors;

Table 3.17-1 Cultural Resource Laws, Regulations, Executive Orders, and Other Federal Authorities

Regulation	Summary
	[Note: In 2016, the Navajo Nation Historic Preservation Department and the Navajo Nation Archaeology Department were combined into a single agency, the Navajo Nation Heritage and Historic Preservation Department.] (3) the Navajo Nation Tribal Museum provides a repository for all cultural resources collected on Navajo lands; (4) a Navajo Nation Register of Cultural Properties; and (5) a Navajo Nation Cultural Landmarks program. The Navajo Nation Cultural Resources Protection Act requires that a sponsor of an undertaking on Navajo Nation land obtain the approval of the Tribal Historic Preservation Office prior to implementing or authorizing the undertaking. The law also prohibits the following activities: (a) On Navajo lands, only those cultural properties designated as open to the public within the boundaries of the Navajo Nation Park or a National Park or National Monument may be visited or investigated; (b) No person may alter, damage, excavate, deface, destroy, or remove any cultural properties on Navajo land; (c) No person may sell, purchase, exchange, or transport cultural resources from Navajo lands; (6) No person may engage in ethnographic research on Navajo lands except for those qualified individuals granted a Navajo Nation Cultural Resources Permit issued by the Tribal Historic Preservation Office, subject to appropriate terms and conditions. Prohibitions against visitation of cultural resources do not apply to enrolled members of the Navajo Nation and Navajo Nation employees engaged in official activities. Prohibitions against alteration, collection, disturbance, excavation or removal of cultural resources or collection of ethnographic data do not apply to Navajo traditional practitioners engaged in activities directly relating to the practice of traditional Navajo religion or Navajo Nation employees engaged in official business related to approved cultural resource management activities. In accordance with the Navajo Nation Cultural Resources Protection Act, the Navajo Nation Historic Preservation Department developed a series of guidelines and policies related to cultural resources on Navajo lands. Among these are: • Policies, Procedures, and Requirements for Acquiring Cultural Resource Investigation Permits; • Cultural Resources Investigation Permit Fee Schedule, Permit Request Forms, and ARPA Permit; • Fieldwork, Report Standards, and Guidelines; • Guidelines for the Treatment of Historic Sites; • Navajo Nation Policy to Protect TCPs; • Guidelines for the Treatment of Historic, Modern, and Contemporary Abandoned Sites;

Table 3.17-1 Cultural Resource Laws, Regulations, Executive Orders, and Other Federal Authorities

Regulation	Summary
	• Navajo Nation Policy for the Protection of *Jishchaa'*: Gravesites, Human Remains, and Funerary Items; and • Guidelines for the Treatment of Discovery Situations.
Arizona Revised Statues 41-841 through 41-844 and its implementing rules, and Arizona Revised Statute 41-865 and its implementing rules. Arizona State Historic Preservation Act of 1982 (Arizona Revised Statutes 41-861 through 41-864). Regulations on the confidentiality of information related to the location of archaeological discoveries or objects included or eligible for inclusion in the Arizona Register of Historic Places (Arizona Revised Statute 39-125).	Arizona Revised Statute 41-841 requires only permitted, qualified individuals acting as authorized agents of an institution or corporation may excavate historic and prehistoric ruins, burials, and paleontological sites on land owned or controlled by the State of Arizona. Arizona Revised Statute 41-842 allows only institutions, organizations, and corporations organized for scientific, research, or land-use planning purposes to pursue activities prescribed in 41-841. It also requires permits must be secured from the Director of the Arizona State Museum to undertake this work. Arizona Revised Statute 41-843 prohibits any person, institution, or corporation from defacing or otherwise altering any site or object embraced within the terms of 41-841 and 41-842 except as permitted by the director of Arizona State Museum. Arizona Revised Statute 41-844 protects human remains and associated funerary objects in unmarked graves and abandoned cemeteries that exceed 50 years in age on state, county, city, and municipal lands in Arizona. This statute also protects sacred ceremonial objects and objects of national or cultural patrimony on state lands that have special importance to American Indians. Arizona Revised Statute 41-865, the Arizona Burial Protection Act (1990), applies to private lands; it provides similar protection to human remains and associated funerary objects that also exceed 50 years in age. Arizona State Historic Preservation Act of 1982 is similar to the NHPA. Arizona Revised Statute-41-861 assigns responsibility to the administrator of each state agency for the preservation of historic properties which are owned or controlled by that agency. Arizona Revised Statute 41-862 requires each state agency locate, inventory, and nominate to the Arizona Register of Historic Places all properties that are under the agency's ownership or control and that appear to meet the criteria for inclusion on the register. In instances where sites cannot be avoided or substantially altered during a project, Arizona Revised Statute 41-863 requires that steps are taken to make appropriate documentary recordation in accordance with standards that the State Historic Preservation Office establishes and deposit those records with the Arizona State Library, Archives, and Public Records and with the State Historic Preservation Office for future use and reference. Arizona Revised Statute 41-364 requires state agencies to consult with the State Historic Preservation Office when planning projects, including sale or lease of state land, which may potentially affect any historic or prehistoric properties. It also says the State Historic Preservation Office has 30 days to review and comment on projects that may impact historic properties on state land. Arizona Revised Statute 39-125 addresses confidentiality of information related to site locations. A public official may decline to release this

Table 3.17-1 Cultural Resource Laws, Regulations, Executive Orders, and Other Federal Authorities

Regulation	Summary
	information if the officer determines that the release of the information creates a reasonable risk of vandalism, theft, or other damage to the archaeological discoveries or the places or objects that are included on or may qualify for inclusion in the State Register of Historic Places.
Utah Code Title 9, Chapter 9, Section 401-406: NAGPRA (1992).	The NAGPRA is the Utah State equivalent to the federal NAGPRA. It protects human remains and associated funerary objects on state, county, city, and municipal lands in Utah. Utah Code Title 9, Chapter 8, Section 309 protects ancient human remains on non-federal, non-state lands in Utah.
Nevada Revised Statute 383.150-190: Protection of Indian Burial Sites (1989).	The Protection of Indian Burial Sites law protects human remains and associated artifacts on non-federal lands in Nevada.

3.17.1.1 Development of Programmatic Agreements

The Section 106 process will be completed prior to the Record of Decision through the execution of Section 106 Programmatic Agreements. As described in 36 CFR Part 800.14(b), the development of programmatic agreements are the most commonly used program alternative for Section 106 compliance. A programmatic agreement is negotiated between the lead federal agency, other land-managing agencies, other key agencies, State Historic Preservation Office(s)/Tribal Historic Preservation Office(s), the Advisory Council on Historic Preservation, Tribes, private entities, and other parties. A programmatic agreement identifies the steps that the lead agency and the consulting parties agree to follow in resolving adverse effects to historic properties.

For the NGS-KMC Project, two programmatic agreements were developed. Reclamation as lead agency, with the approval of the Advisory Council on Historic Preservation, created two programmatic agreements because the potential effects to historic properties in the proposed KMC are markedly different than potential effects to other project components. The programmatic agreement regarding the management of historic properties at the proposed KMC, was developed to address potential effects to historic properties within the proposed KMC boundary. No new construction is anticipated for the NGS portion of the project; therefore, the NGS Programmatic Agreement was developed to address the potential for effects from routine operation and maintenance (O&M) activities within all other portions of the study area, including the NGS and the transmission system.

Given land ownership and leasing agreements on Indian land, Reclamation prepared the KMC Programmatic Agreement in consultation with entities listed in **Table 3.17-2**. The KMC Programmatic Agreement outlines general and specific measures that Reclamation and OSMRE would take to fulfill their responsibilities to consider the effects of their actions on historic properties under the NHPA and Tribal laws. As part of the programmatic agreement process, Reclamation sent letters to local governments, agencies and other entities inviting them to be consulting parties to the agreement. Those that accepted Reclamation's invitation are listed in **Table 3.17-2**. Also involved are several non-governmental organizations who have expressed interest and been involved in the overall project through submission of comments during scoping meetings, attendance at Cultural Resource Update Meetings, and participation in invited Listening Sessions. These organizations include Black Mesa Coal'tion, Black Mesa Conservancy, Black Mesa Trust, Black Mesa Water Coalition, Black Mesa United, Diné CARE, Forgotten Navajo People, and To' Nizhoni Ani.

Table 3.17-2 KMC Programmatic Agreement Consultation

Tribal Governments Consulted	Other Entities Consulted
Navajo Nation	Advisory Council on Historic Preservation
Hopi Tribe	Arizona State Historic Preservation Office
Pueblo of Zuni	Bureau of Indian Affairs (BIA)-Navajo Region
	BIA-Western Region
	OSMRE
	Peabody Western Coal Company (PWCC)

The NGS Programmatic Agreement was prepared in consultation with entities listed in **Table 3.17-3**. As with the KMC Programmatic Agreement, the NGS Programmatic Agreement outlines general and specific measures that Reclamation would take to fulfill its responsibilities to resolve effects to historic properties under the NHPA, Tribal laws (**Table 3.17-1**), and state laws. As part of the programmatic agreement process, Reclamation sent letters to the parties listed in **Table 3.17-3**, inviting them to be consulting parties to the agreement. Those that accepted Reclamation's invitation to participate have as yet to be determined as of July 15, 2016.

Table 3.17-3 NGS Programmatic Agreement Consultation

Tribal Governments Consulted	Other Entities Consulted
Ak-Chin Indian Community	Advisory Council on Historic Preservation
Cedar Band of Paiutes	Arizona Public Service Company
Fort McDowell Yavapai Nation	Arizona State Historic Preservation Office
Fort Mojave Indian Tribe	Arizona State Lands Department
Fort Yuma-Quechan Tribe	Arizona State Museum
Gila River Indian Community	BIA-Navajo Region
Havasupai Tribe	BIA-Western Region
Hopi Tribe	Bureau of Land Management (BLM)
Hualapai Tribe	National Park Service – Glen Canyon National Recreation Area)
Indian Peaks Band of Paiutes	NV Energy
Kaibab Band of Paiutes	Nevada State Historic Preservation Office
Kanosh Band of Paiutes	Salt River Project Agricultural Improvement and Power District
Koosharem Band of Paiutes	U.S. Forest Service – Southwest Regional Office, Kaibab National Forest, Prescott National Forest
Las Vegas Paiute Tribe	Utah State Historic Preservation Office
Moapa Band of Paiutes	—
Navajo Nation	—
Paiute Indian Tribe of Utah	—
Pascua Yaqui Tribe	—
Pueblo of Zuni	—
Salt River Pima-Maricopa Indian Community	—
San Carlos Apache Tribe	—

Table 3.17-3 NGS Programmatic Agreement Consultation

Tribal Governments Consulted	Other Entities Consulted
San Juan Southern Paiute Tribe	—
Shivwits Band of Paiutes	—
Southern Ute Indian Tribe	—
Tohono O'Odham Nation	—
Tonto Apache Tribe	—
Ute Indian Tribe of the Uintah and Ouray Reservation	—
Ute Mountain Ute Tribe of the Ute Mountain Reservation	—
White Mountain Apache	—
Yavapai-Apache Nation	—
Yavapai-Prescott Indian Tribe	—

The NGS and KMC Programmatic Agreements would stipulate how historic properties are identified and establish a process for assessing and resolving effects to historic properties. Measures to resolve effects (avoidance, minimization, or mitigation) to historic properties are built into the two programmatic agreements. Effects to historic properties would be anticipated in the proposed KMC where permitted mining and mine preparation activities likely would result in effects to historic properties. In anticipation of these effects, the KMC Programmatic Agreement establishes specific procedures to avoid, minimize, and resolve effects. These include avoidance measures designed to ensure against effects if and when mine-related activities are in proximity to known NRHP eligible historic properties, such as archaeological sites and TCPs. Provisions for monitoring any ground disturbing activities near historic properties also are provided to supplement avoidance procedures when needed. When avoidance is not practicable, PWCC would be required to follow stipulations designed to ensure that any effects to historic properties are resolved before mine related activities begin. Preparation of a Historic Properties Treatment Plan will be required to guide all necessary treatment activities. The Historic Properties Treatment Plan will be prepared in consultation with the parties to the programmatic agreement and agreed to in advance of mine-related activities. All approved treatment activities will be reported after the investigations are completed.

The KMC Programmatic Agreement addresses the discovery of human remains and objects of cultural patrimony as required under Tribal law and policy and in compliance with the NAGPRA. It specifies that the lead federal agency will treat all human remains with dignity and respect, and those remains will be reburied or curated in consultation with the affected Tribes. All cultural materials recovered through approved treatment will be curated in a facility located either on the Navajo or Hopi reservations, as applicable, or in an off-reservation facility as approved by the Tribes and the lead federal agency. It should be noted that the Navajo Nation has a reburial policy that stipulates the reburial of cultural materials recovered from archaeological excavation (**Table 3.17-1**, Navajo Nation Policy for the Protection of *Jishchaa'*: Gravesites, Human Remains, and Funerary Items).

The NGS Programmatic Agreement also addresses the potential for effects that may result from current and future O&M activities and the resolution of any effects that may occur. No new construction is planned for any of the project elements outside of the proposed KMC; therefore, the NGS Programmatic Agreement focuses on O&M tasks. It is anticipated that many such tasks would have no potential to cause effects and may be exempted from Section 106 consultation; however, the programmatic agreement includes provisions for when effects to historic properties may occur, as negotiated with

Tribes, the lead agency, and other parties to the programmatic agreement. Procedures for resolving any effects also are included.

Provisions for addressing the discovery of human remains is included in the NGS Programmatic Agreement. On federal and tribal lands, such discoveries will follow NAGPRA, as well as Tribal law and policy, where applicable. On state, municipal, and private lands, the discovery of human remains will abide by applicable state burial laws. The lead federal agency will treat all human remains with dignity and respect and the disposition of those remains will be carried out in consultation with Tribes and other parties.

3.17.2 Study Areas

3.17.2.1 Proposed Action and Action Alternatives

The study area for identifying cultural resources for the Proposed Action and action alternatives corresponds to the project limits, as defined by lease and permit boundaries and rights-of-way (ROWs), for all elements of the NGS)-KMC Project. Based on current information, the study area consists of the following features discussed below (**Figure 3.17-1**).

3.17.2.1.1 Navajo Generating Station

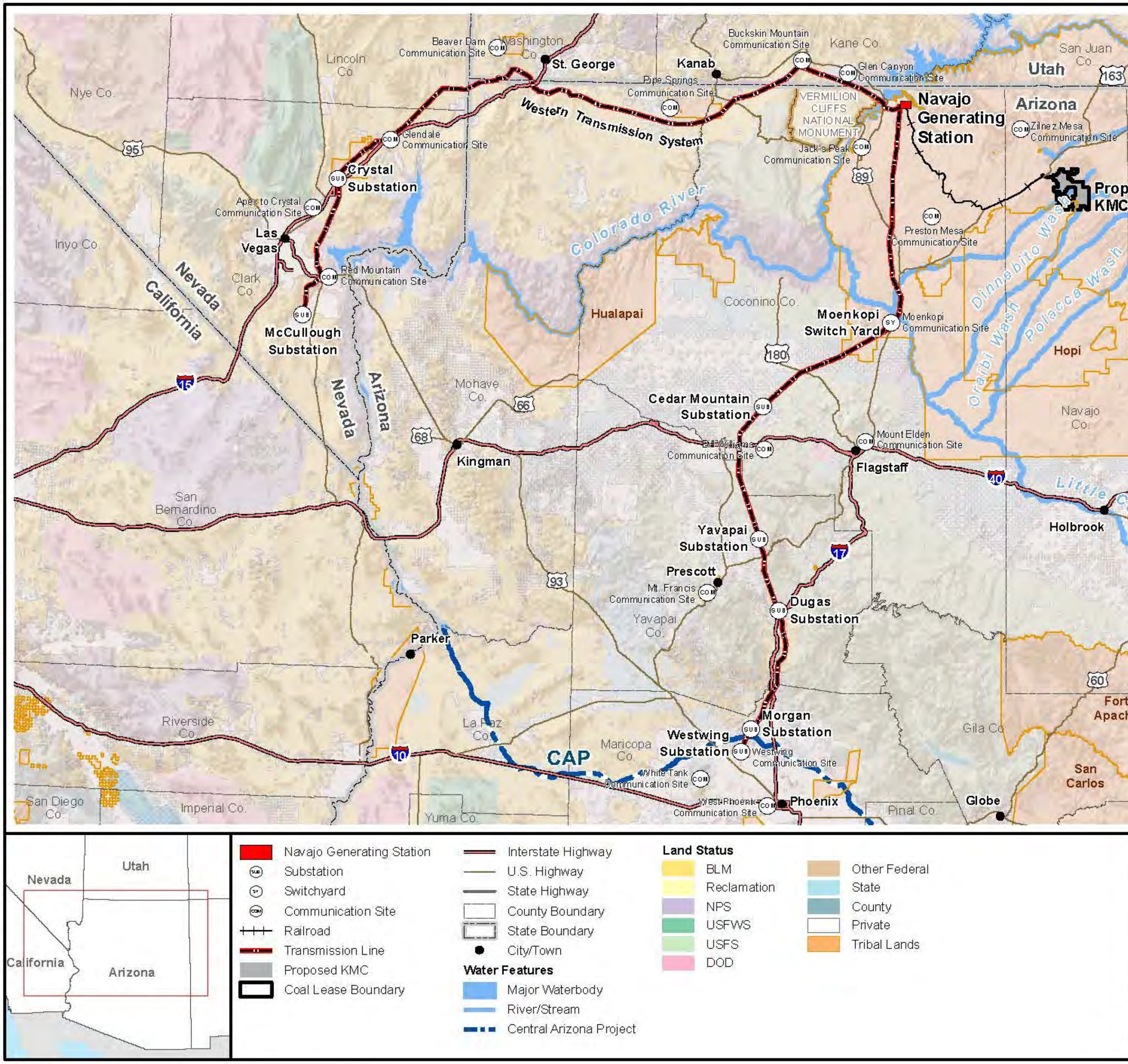
The NGS portion of the cultural resources study area consists of the footprints of the facilities listed in **Table 1-2**. The NGS cultural resources study area includes the following components:

- The NGS plant site;
- The ash disposal site;
- The road between the plant site and the ash disposal site;
- The lake pump station;
- The road between the lake pump station and N22b;
- The pipeline, powerlines, and road between the lake and the plant site;
- The 230-kilovolt (kV) tie line;
- The Black Mesa & Lake Powell (BM&LP) Railroad ROW, which varies in width between 100 and 560 feet; and
- The coal loadout silo.

For the purposes of the analyses in this section, the BM&LP Railroad and the coal loadout silo are considered together but separate from the remainder of the NGS and associated facilities.

3.17.2.1.2 Proposed Kayenta Mine Complex

- The study area of the proposed KMC consists of lands contained within the 62,930 acres of land covered by the OSMRE permit AZ-0001E (**Figure 3.17-2**). This study area includes the former Black Mesa Mine and associated infrastructure. See Section 1.7.2 for a description of the Kayenta Mine and the former Black Mesa Mine.
- Within the study area of the proposed KMC are lands that would be affected by the Proposed Action (**Figure 3.17-2**). These lands consist of the following:



Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 3.17-1 Cultural Resources Project Overview

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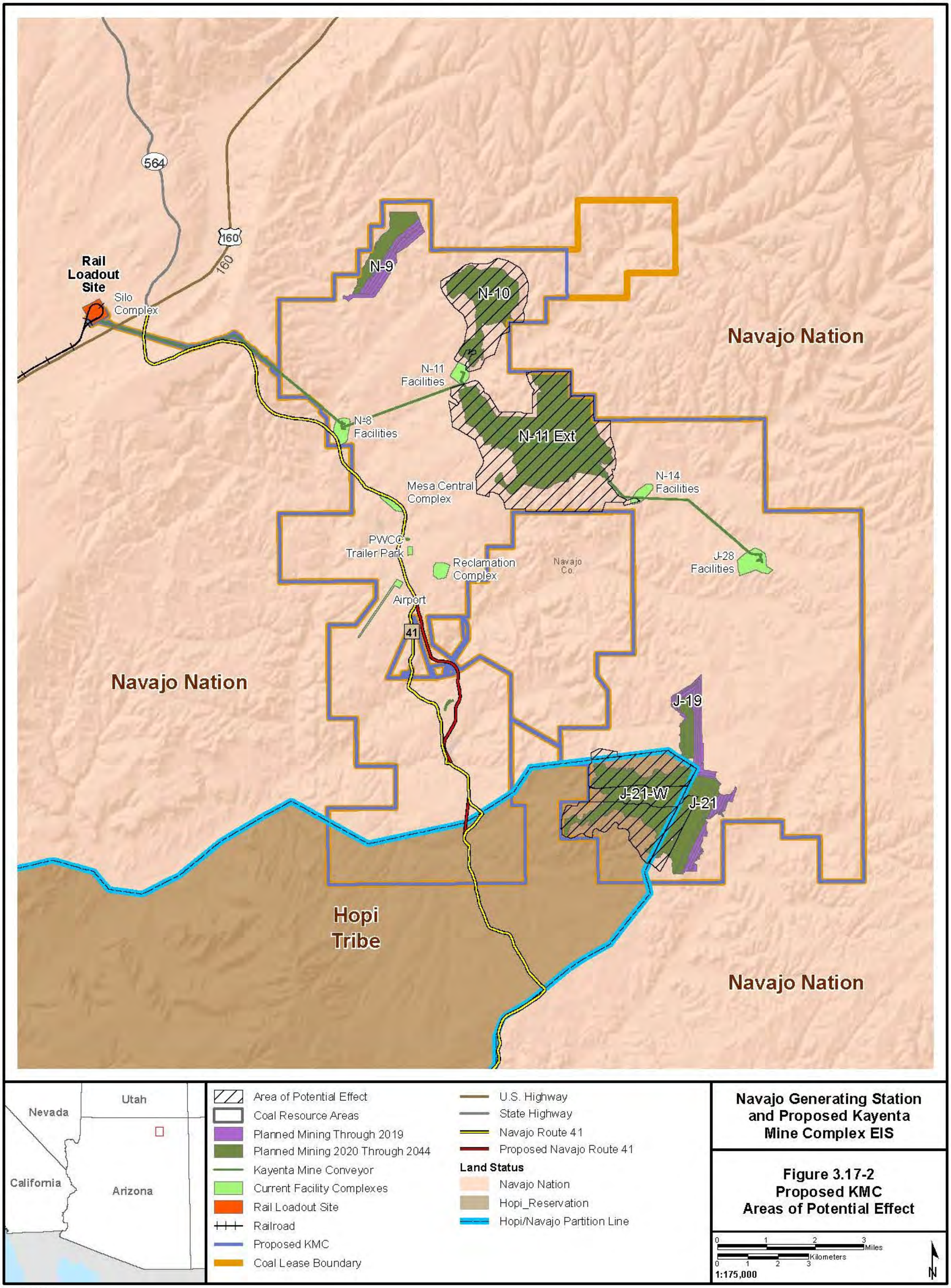

Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 3.17-2
Proposed KMC
Areas of Potential Effect

7/29/2016

1. The affected lands associated with the five proposed mine areas: J-19, J-21, J-21 West, N-10, and N-11 Extension. These affected lands include reclaimed areas within N-10 and N-11 Extension (**Table 3.17-4**).
2. The coal conveyor that runs from the J-28 facilities to the Silo Complex and the terminus of the BM&LP Railroad. The corridor of the coal conveyor belt consists of a 50-foot-wide buffer on both sides of the centerline of the belt.
3. Two new proposed rerouted sections of Navajo Route 41. The corridors of these two new sections of Navajo Route 41 consist of 50-foot-wide buffers on both sides of their centerlines.
4. Existing facilities in the proposed KMC. These consist of the facilities in J-28, N-8, N-11, and N-14 in the current Kayenta Mine; the Airport, Mesa Central Complex, PWCC Trailer Park, and Reclamation Complex in the former Black Mesa Mine; and the southern portion of the Silo Complex at the terminus of the coal conveyor. Section 1.7.2.1 presents more detailed descriptions of these facilities.

Table 3.17-4 Affected Environment Lands within the Proposed KMC

Mine Area	Acreage
J-19	55
J-21	296
J-21 West	2,300
N-10[1]	956
N-11 Extension[2]	3,553

[1] N-10 acreage excludes 616 acres of reclaimed land.

[2] N-11 Extension acreage excludes 863 acres of reclaimed land.

3.17.2.1.3 Transmission Systems and Communication Sites

3.17.2.1.3.1 Western Transmission System

- The single circuit line 500-kV Western Transmission System (WTS) is approximately 275 miles long with a ROW varying in width from 200 to 330 feet. The line begins at the NGS and terminates at the McCullough Substation southeast of Las Vegas, Nevada (**Figure 3.17-1**).
- The McCullough Substation and Crystal Substation are parts of the WTS.
- Multiple transmission corridor access roads are part of the WTS, including primary access roads to the corridors that will be maintained by the transmission line operators and, in some cases, secondary roads that connect to the primary roads.

3.17.2.1.3.2 Southern Transmission System

- The double circuit line 500-kV Southern Transmission System (STS) is approximately 256 miles long with a ROW varying in width from 230 to 330 feet. The line begins at the NGS and terminates at the Westwing Substation north of Phoenix, Arizona (**Figure 3.17-1**).
- The Moenkopi Switchyard and the Cedar Mountain, Yavapai, Dugas, Morgan, and Westwing substations are part of the STS.
- Multiple transmission corridor access roads that will be maintained by the transmission line operators are part of the STS.

3.17.2.1.3.3 Communication Sites

- Nineteen communication sites also are used to maintain the operation of the NGS, WTS, and STS.
- Fifteen of the 19 communication sites are external to the footprints of other NGS-KMC Project features (**Figure 3.17-1**). The study areas for these 15 external communication sites are a 100-meter buffer surrounding the point location of each site as defined by Salt River Project Agricultural Improvement and Power District.

3.17.2.2 Cumulative

The study area for evaluating cumulative impacts to cultural resources is the same as the study area for the Proposed Action and action alternatives and corresponds to the project limits, as defined by lease and permit boundaries and ROWs, for all elements of the NGS-KMC Project. This includes the NGS, the proposed KMC, and the transmission systems and communication sites. The study area is depicted **Figure 3.17-1** and is described in Section 3.17.2.1. The study area includes a portion of Black Mesa, which as a TCP and is part of a larger Traditional Cultural Landscape (TCL). Ongoing ethnographic studies conducted for the NGS-KMC Project will provide important information concerning cumulative impacts to TCPs and other cultural resources in the study area.

3.17.3 Affected Environment

This section provides: 1) a description of the data collected and used for this analysis; 2) a brief introduction to the cultural history of the project and the Native American tribes who live in and adjacent to the project study area; and 3) a description of the affected environment for cultural resources described by project feature, all of which are common to all project alternatives. Given the size of the study area, only a brief introduction to the cultural diversity, culture history, and the Native American tribes associated with the study area is given here. A more detailed treatment of archaeological cultural resources can be found in the cultural resources records search report (Graves 2015).

3.17.3.1 Data Collection

An inventory of archaeological sites, historic architectural resources, and TCPs known to lie within the study area was compiled through a variety of file searches, archaeological surveys, and ethnographic/ TCP investigations. Some of these data collections are complete, whereas others are on-going or stipulated in the project programmatic agreements. These investigations provide the baseline for understanding potential impacts to cultural resources and historic properties under the different project alternatives and are introduced briefly in this section.

A Class I-level cultural resources records search and literature review was completed for the project (Graves 2015). The records search consisted of a search of existing literature and site and project documentation to create a project-wide cultural resources geodatabase and bibliography of cultural resources research. The records search included the project study area plus a 100-meter-wide buffer. In conjunction with the 2015-2016 pedestrian resurvey of the WTS, 1-mile-wide buffer on either side of the centerline of the transmission line corridor was used to provide more extensive background data and literature review. The records search also included the entire mine leasehold area, not just the specific lands of the proposed KMC described in **Table 3.17-4**.

The records search was conducted to document and characterize the nature and extent of known cultural resources within and adjacent to the study area. **Table 3.17-5** lists the repositories and institutions from which data were acquired. Graves (2015) lists the attributes for which information was acquired for cultural resources and previously conducted cultural resources investigations. In addition to non-spatial attribute data, geographic information systems locational data also were acquired for resources and cultural resources investigations within the project area and a 100-meter buffer. Resources included in the records search and literature review consisted of prehistoric and historical period archaeological sites, historic architectural resources, and TCPs. The study defined appropriate research contexts and themes with which the significance of cultural resources can be evaluated and was concerned primarily with archaeological cultural resources. It also identified geographic spaces within the study area where cultural resource inventory was either lacking or potentially outdated, as well as gaps in knowledge concerning the nature and distribution of cultural resources. However, it is important to note that ethnographic studies of TCPs and TCLs also are being conducted to more fully understand the cultural resources of the project area, including places of religious and cultural significance. Tribes are being consulted regarding the incorporation of Tribal-specific traditions and culture into research contexts and themes appropriate to future Historic Properties Treatment Plans associated with mitigation of effects to cultural resources.

Table 3.17-5 Repositories and Institutions Providing Data for the Cultural Resources Records Search and Literature Review

Repository/Institution
Arizona Public Service Company
Arizona State Museum and AZSITE
Museum of Northern Arizona
Navajo Nation Historic Preservation Department (including the Traditional Cultural Program)
Nevada State Historic Preservation Office, Nevada Cultural Resource Information System, and the Southern Nevada Archaeological Archive
PWCC
Southern Illinois University, Center for Archaeological Investigations
Salt River Project
BLM, Arizona Strip Office
BLM, Southern Nevada District, Las Vegas Office
Bureau of Reclamation, Lower Colorado Region, Boulder City and Phoenix Offices
Coconino National Forest
Kaibab National Forest
Prescott National Forest
Glen Canyon National Recreation Area
OSMRE
Utah State Historical Society

Source: Graves 2015.

Information was collected about the NRHP eligibility status of the cultural resources identified (Graves 2015). Those cultural resources considered historic properties, those not considered historic properties, and those for which NRHP-eligibility has not been evaluated were identified. Documentation for the mine leasehold area was obtained from both OSMRE and PWCC. The records search and literature review did not find supporting documentation for any other sites in the other project components of the study area that were identified through data collection efforts as having been determined eligible for listing in the NRHP. Graves (2015) provides a more in-depth discussion of the NRHP-eligibility data of sites identified during the course of the records search inventory.

Previous surveys of the PWCC mine lease area were conducted in the late 1960s, 1970s, and early 1980s through the Black Mesa Archaeological Project (BMAP). New survey methods and technologies have increased the ability to identify and precisely locate archaeological sites on the landscape. In 2014, the Data Quality Assessment Survey (DQAS) was conducted on just over 850 acres within areas proposed for mining to evaluate the quality of cultural resources documentation in those areas. The description and results of this survey are reported in the cultural resources records search report (Graves 2015). Locations were selected for survey within the affected lands associated with the five mine areas: J-19, J-21, J-21 West, N-10, and N-11 Extension (**Figure 3.17-2**). The survey evaluated the accuracy of site plots, determined the completeness of prior site identification and site recording, and provided a preliminary assessment of the nature and extent of potential culturally important sites that might not have been identified during or after the BMAP.

In addition to archaeological resources, the literature and records search identified a small number of recorded TCPs within the footprint of the entire study area. These properties comprise only a partial inventory of the total number of existing potential TCPs for the project (Graves 2015). PWCC also has sponsored a number of small-scale ethnographic/TCP investigations within both the former Black Mesa Mine and the Kayenta Mine from 1994 to 2014 (PWCC 2012 et seq.). Information from these studies is included in the discussions and analysis of TCPs.

In addition to the studies described above, several cultural resource studies are underway or planned for the NGS-KMC Project. These studies provide additional information about the distribution and nature of cultural resources throughout the study area and address the data gaps and missing information identified by the inventory and the DQAS (Graves 2015). These additional studies include:

- Ethnographic/TCP and TCL study for the Navajo Nation of proposed mining areas within the proposed KMC. The study consisted of a literature search on the relevant environmental, ethnohistorical, and ethnographic information and data pertaining to the proposed KMC and Black Mesa; collection and analysis if background data; training of three Navajo student interns to assist with project tasks; outreach efforts with Navajo Chapters, medicine men associations, and non-governmental organizations; numerous outreach meetings and interviews with Navajo residents living within the proposed KMC area, as well as follow-up meetings with the same residents to confirm the accuracy of recorded information; site visits and interviews with KMC residents, representatives of Black Mesa United and Black Mesa Review Board, and Chapter House representatives; and development of 7) developed a variety of geographic information systems-enabled maps to assist with the identification of TCPs and characterization of TCLs; 8) transcribed interviews; and 9) begun drafting sections of the ethnographic report.
- Ethnographic/TCP/TCL study for the Hopi Tribe of proposed mining areas, as well as TCP overview for all other portions of the study area. Ethnographers in collaboration with members of the Hopi Tribe, have completed focused fieldwork in coal resource areas N-10, N-11 Extension, J-21, and J-21 West within the Kayenta Mine, as well as portions of the former Black Mesa Mine. The BM&LP Railroad, the NGS facility, WTS, and the STS also have been inspected through a vehicular survey. To date, 49 members of the Hopi Tribe, including tribal members from all 12 Hopi villages and men and women from 23 different clans, have participated in fieldwork and interviews. This collaborative effort has resulted in identification of TCPs in the proposed KMC; documentation of Hopi history and traditions in the broader region to develop a cultural and historical context for Hopi TCPs identified within the study area; evaluation of effects of mining on Hopi TCPs within the proposed KMC and associated facilities under NHPA; 4) identification of direct, indirect, or cumulative impacts that mining may have on the Hopi people under the National Environmental Policy Act; and recommendations on behalf of the Hopi Tribe concerning proposed activities in the proposed KMC. In addition, research has been conducted on water sources and springs within the proposed KMC that are culturally important to the Hopi Tribe and archival research pertinent to the identification and evaluation of TCPs.
- Ethnographic/TCP/TCL overview for the Pueblo of Zuni for the entire NGS-KMC Project study area. This study began in the spring of 2016.

- Ethnographic/TCP/TCL overview of the WTS, STS, and 19 communication sites for Tribes with traditional and on-going religious and cultural practices that intersect the KMC-NGS Project study area. This study will begin during the fall of 2016.
- Intensive, pedestrian cultural resources survey of the entire WTS corridor ROW including access roads. A field survey of the 274-mile-long WTS corridor in Arizona, Nevada, and Utah was completed on February 23, 2016. Approximately 190 sites were identified; approximately half of these 190 sites were newly recorded. Data analysis and report preparation is in progress.
- Intensive, pedestrian cultural resources surveys of the lands not included in the DQAS within the affected lands associated with the proposed mine areas. The survey of Hopi Tribal lands in J-21 West was undertaken from April through June 2016. The survey of Navajo Nation lands in N-10, N-11 Extension, J-19, and J-21 was undertaken in August 2016.

3.17.3.2 Overview: Cultural History and Federally Recognized Tribes

The study area encompasses a vast portion of the U.S. Southwest and traverses a remarkable diversity of the environmental zones and cultural-historical areas in Arizona, Nevada, and Utah. To facilitate this discussion, the study area has been divided into meaningful segments (cultural-environmental areas) based on variability in geography, archaeology, and cultural history (**Figure 3.17-3**). The following discussion is based in a Western normative view of prehistory that has not included Native American views of the prehistoric past. However, the cultural-historical categories used here provide a temporal sequence that contributes to the larger archaeological record of the U.S. Southwest. In order to capture Native American perspectives of the prehistoric past, the ethnographic TCP/TCL inventories will provide an Indigenized cultural-historical temporal sequence that reflects tribal oral histories.

3.17.3.2.1 Cultural-environmental Areas

3.17.3.2.1.1 Kayenta Area

The Kayenta Area includes those portions of the study area that lie within the Navajo Nation and the Hopi reservations. Archaeologically, the Kayenta Area has been characterized by a distinctive set of material culture, site structure, and settlement patterns (Dean 1996; Schachner et al. 2012). This was the heartland of the Kayenta Anasazi/Ancestral Pueblo people. Throughout this cultural resource section, the phrase Anasazi/Ancestral Pueblo is used to reflect the preferred terms of the Navajo (Anasazi) and the Hopi (Ancestral Pueblo) for the same archaeological cultural-historical sequence.[1]

3.17.3.2.1.2 Southern Utah, Southeastern Nevada, and Arizona Strip Area

Located west of the Kayenta area, this cultural-environmental area includes the very western extent of the Kayenta Anasazi/Ancestral Pueblo occupation. The Southern Utah, Southeastern Nevada, and the Arizona Strip Area is located approximately between the Colorado River and Kanab Creek, and the Virgin Anasazi/Ancestral Pueblo area, which extends from the Virgin River and Muddy River drainages on the west to Kanab Creek on the east (Lyneis 2000, 1996). This region also is home to the Southern Paiute (Euler 1966; Kelly 1934; Kelly and Fowler 1986).

[1] Navajo Nation recently has requested non-Navajos use the Navajo term “Nihinasaazi” meaning “the Ancestors” rather than the archaeological term, “Anasazi” when referring to the archaeological cultural-historical sequence that occurs on Navajo lands (Ora Marek-Martinez, Navajo Nation Tribal Historic Preservation Officer, correspondence dated July 2015).

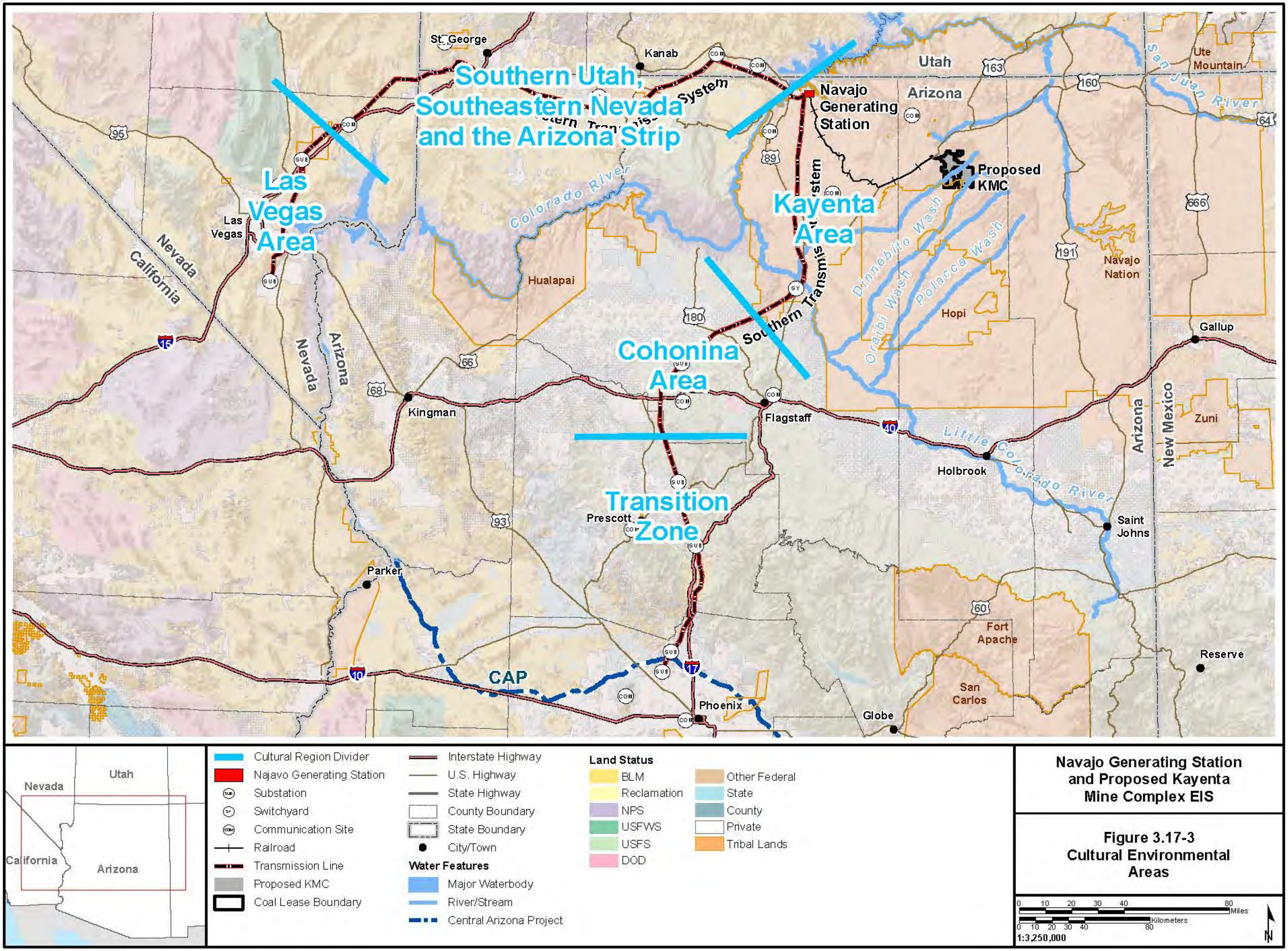

Figure 3.17-3
Cultural Environmental Areas

3.17.3.2.1.3 Las Vegas Area

After crossing the Muddy River and entering the Moapa River Indian Reservation, the study area enters the Las Vegas Area. This cultural-environmental area traverses the more arid Mojave Desert, and the archaeological record reflects a mix of Virgin Anasazi/Ancestral Pueblo and Patayan archaeological cultural traits. Historically, the Las Vegas Area has been home to Southern Paiute groups as well as Yuman-speaking groups along the Colorado River (Roberts 2012).

3.17.3.2.1.4 Cohonina Area

South of the Kayenta Area lies the Cohonina Area. This cultural-environmental area extends from the boundary of the Navajo Nation on the north to the approximate edge of the Colorado Plateau and the upper Verde River valley. The Cohonina Area is home to the Cohonina archaeological culture and, during the Late Prehistoric/Protohistoric and Historical periods, was inhabited and used by several Native American tribes, including the Havasupai, the Yavapai, the Navajo, and the Hopi (Cleeland et al. 1992).

3.17.3.2.1.5 Transition Zone

This cultural-environmental area lies south of the Cohonina Area encompassing the portion of central Arizona lying between the desert basins and ranges to the south and the Colorado Plateau to the north (Whittlesey and Ciolek-Torrello 1998). The Transition Zone encompasses a vast and diverse region with considerable topographic relief and environmental and biotic diversity. The Sinagua, Cohonina, Prescott, Central Arizona Tradition, and Hohokam archaeological cultures all are present in this area. The Transition Zone was home territory of the Northeastern Yavapai, and the Yavapai-Prescott Tribe; the Yavapai-Apache Nation reservations also are located in this area.

3.17.3.2.2 Cultural History

3.17.3.2.2.1 Paleoindian Period

Within the areas intersected by the NGS-KMC Project, the beginning dates of the Paleoindian Period range from 11,150 BC to 9,950 BC. Ending dates for this period range from 10,850 BC to 7,050 BC. The Paleoindian Period occupation of the region generally is represented by rare surface or isolated finds of fluted, Clovis-style projectile points similar to other fluted points found throughout the U.S. Southwest and the Great Basin (Roth 2012). Archaeological evidence of the period indicates the existence of an adaptation based on the hunting of large game that concentrated on extinct Pleistocene species of mammoth (Mammuthus), bison (Bison), and other megafauna. Paleoindian Period hunter-gatherers use and occupation of the entire region was sporadic and generally reflects occasional hunting forays into the area by small, mobile groups following the migratory corridors of large game (Jones and Edwards 1994; Roth 2012).

3.17.3.2.2.2 Archaic Period and Basketmaker II/Terminal Archaic Period

Based largely on changing projectile point styles and artifact-assemblage variability, the Archaic Period across the study area is divided into three temporal categories: the Early (9050-7000 BC to 5550-4250 BC); Middle (5500-3500 BC to 2650-2000 BC); and Late (2600-2000 BC to 400 BC-AD 400) Archaic periods. The ranges in the beginning and ending dates of these periods reflect the variation in the changes in the archaeological record that form the basis of the dating of these periods among the cultural-environmental areas the traversed by the study area. In the Southern Utah, Southeastern Nevada, and the Arizona Strip Area and the Kayenta Area, a preceramic Basketmaker II Period (AD 1 to 500) that overlaps the Late Archaic Period has been defined. This period is called the Terminal Archaic in the Las Vegas Area.

During the Early Archaic Period, human groups began to rely less on big-game hunting and more heavily on plant and small-animal resources for subsistence. Overall, the record of the Early Archaic Period across the study area reflects an adaptation focusing on wetland resources and a wide variety of hunted and gathered resources that required relatively little storage and processing such as grinding, roasting, or parching (Roth 2012). The density of Early Archaic Period sites across the footprint of the study area is low.

There is an increase in the frequencies of sites and isolated surface projectile points that date to the Middle Archaic Period throughout the cultural-environmental areas that intersect the study area. This increase in sites and points may indicate an increase in the size of populations occupying these areas and a more-intensive use of the landscape. A focus on plant processing also is evident in the observed increase and elaboration of ground stone implements recovered from Middle Archaic Period sites (Sayles and Antevs 1941). Overall, the archaeological record of the Middle Archaic Period reflects a hunter-gatherer adaptation where people were still reliant on hunting but were becoming more generalized in their subsistence pursuits and were exploiting a wider variety of food resources compared to earlier time periods.

Subsistence and settlement practices apparently continued to intensify during the Late Archaic Period and the Terminal Archaic and Basketmaker II periods throughout the U.S. Southwest. The frequency of sites appears to increase dramatically from the Middle Archaic Period to the Late Archaic Period and consist of a wide variety of site types including caves and rockshelters, rock art, and open-air artifact scatters. The Late Archaic Period also was a time of residential stability and the formation of village settlements of hunter-gatherers and farmers. Settlement permanency and subsistence strategies intensified during this period, with an increasing reliance on big-game hunting and more intense plant use and processing. The period witnessed decreasing residential mobility and the formation of relatively stable residential campsites.

As early as 2000 BC, domesticated crops arrived in the U.S. Southwest, and groups began to practice agriculture (Huber 2005; Huckell 1996, 1995; Matson 1991; Wills and Huckell 1994). In the Kayenta area, a Late Archaic period hunter-and-gather economy may have existed that was contemporaneous with more agriculturally focused groups dating to the Basketmaker II Period. The possibility of Late Archaic/Basketmaker II Period hunter-and-gather groups and early agricultural groups functioning concurrently also has been suggested in southern Arizona (Huckell 1996) as that region also experienced profound cultural changes during the Late Archaic Period, including the adoption of domesticated-plant resources such as maize. The existence of roughly contemporaneous hunter-gather and farming subsistence strategies during the end of the Late Archaic Period and during the Terminal Archaic/Basketmaker II periods may indicate that different cultural groups inhabited each of the cultural-environmental areas traversed by the study area, or it may indicate that human groups practiced diverse settlement and subsistence strategies and did not rely exclusively on either farming or hunting-and-gathering.

3.17.3.2.2.3 Ceramic Period

The widespread adoption of ceramic technology and the intensification of agricultural practices are hallmarks of the Ceramic Period throughout the study area. The chronology of the Ceramic Period in the Kayenta Area consists of the Basketmaker III Period (ca. AD 550-850), the Pueblo I and II periods (ca. AD 850-1150), and the Pueblo III Period (ca. AD 1150-1300) (the subsequent Pueblo IV Period (ca. AD 1300-1600) is discussed below as part of the Late Prehistoric/Protohistoric Period). The Basketmaker III Period witnessed substantial changes in technology, architecture, settlement, and construction throughout the Kayenta Area, including the widespread adoption of ceramics, farming of maize, the adoption of bow-and-arrow technology, the construction of larger, more-permanent pit houses, and more formal settlement layouts. The Pueblo I Period is characterized by the addition of aboveground masonry storage rooms, ceremonial pit structures or kivas, and formalized site configurations known as unit pueblos (Powell 2002). During the Pueblo II period in the Kayenta area, kiva construction became more standardized and aboveground masonry or jacal (wattle-and-daub) habitation structures were more commonly constructed. By about AD 900, population in the area peaked and settlements were more numerous and widespread. At the beginning of the Pueblo III Period (AD 1150) many of the outlying parts of the Kayenta Area, such as the Grand Canyon, western Glen Canyon, and the northern Black Mesa areas, were abandoned and populations were concentrated in several core areas, including Long House Valley, Marsh Pass, Tsegi Canyon, Rainbow Plateau/Navajo Mountain, Canyon de Chelly, and the Hopi Buttes (Powell 2002). By the end of the Pueblo III Period (ca. AD 1275-1300), the Kayenta area, along with the overall San Juan Basin, was largely depopulated and many Kayenta groups left their homeland and emigrated to the Hopi Mesas, the Homol'ovi area of the Little Colorado River, and beyond (Adams 2002; Lyons 2003).

The Ceramic Period in the Southern Utah, Southeastern Nevada, and the Arizona Strip Area began with the adoption of agriculture and ended with the prehistoric abandonment of the area by AD 1300. This time period is divided into the Basketmaker III Period (AD 550-850), the Pueblo I Period (AD 850-1000), the Pueblo II Period (AD 1000-1150), and the Pueblo III Period (AD 1150-1300). The Ceramic Period in the Southern Utah, Southeastern Nevada, and the Arizona Strip Area was characterized by the presence of two different archaeological-cultural traditions. The Kayenta Anasazi/Ancestral Pueblo tradition extends west into the eastern portion of the area to roughly Kanab Creek. From Kanab Creek to the Muddy and Virgin River valleys, the Virgin Anasazi/Ancestral Pueblo tradition characterizes the Ceramic Period. The Basketmaker III Period marked a number of important technological changes in the area such as the introduction of bows and arrows and ceramic containers, as well as advances in ground stone technology associated with maize farming (Reed 2000). These developments would have had considerable impacts on hunting, storage, and culinary behaviors. The Pueblo I Period was characterized by increasing population and numerous changes in technology and settlement practices, such as the increasing production and use of decorated ceramics, the introduction and widespread construction of aboveground residential architecture, and the increasing aggregation of populations into small unit pueblo settlements (Fairley 1989; Lyneis 1995). The Pueblo II Period witnessed continued population increase and an expansion of populations into previously unoccupied areas (Euler et al. 1979; Noble 2006; Varien 1999). Sites in the Arizona Strip were culturally diverse and often included cultural markers from both Kayenta Anasazi/Ancestral Pueblo and Virgin Anasazi/Ancestral Pueblo traditions. The eastern portion of the Arizona Strip witnessed a Kayenta intrusion ca. AD 1050 (Gumerman and Dean 1989; Lyneis 1996). In southeastern Nevada, the Pueblo II Period marks the height of the Virgin Anasazi/Ancestral Pueblo occupation. Residential sites such as the Lost City complex provide a wealth of information about lifeways in the Muddy River and Virgin River valleys during this time. By AD 1150, the beginning of the Pueblo III Period, much of southern Utah and the Arizona Strip were completely abandoned (Effland et al. 1981; Euler and Chandler 1978; Lyneis 1996; Schwartz et al. 1980). In the Muddy River and Virgin River valleys, there is evidence for the continuation of Virgin Anasazi/Ancestral Pueblo populations well into the AD 1200s, with abandonment of the area by AD 1300.

The Ceramic Period in the Las Vegas Area includes the Basketmaker III (AD 500-800), Pueblo I (AD 800-1000), Pueblo II (AD 1000-1200), and Pueblo III (AD 1200-1300) periods (Ahlstrom and Roberts 2012). The Basketmaker III and Pueblo I periods are represented by only a few archaeological sites that generally consist of small habitation structures, flaked stone tools, pottery, and domesticated corn remains. The Pueblo II and Pueblo III periods saw a great population increase, similar to contemporary population increases to the east. The Las Vegas Area also had non-Anasazi/Ancestral Pueblo occupations; the area also includes archaeological materials of the Patayan archaeological culture during these periods. The Patayan were located in the Las Vegas area and along the Colorado River (McGuire and Schiffer 1982). Patayan people are believed to be the ancestors of the modern Yuman-language-speaking people who live along the lower Colorado River (Roberts 2012).

The Ceramic Period in the Cohonina Area is defined by the appearance of pottery ca. AD 400 and an overall increase in population until sometime in the 1200s, when the area apparently was abandoned. The Ceramic Period is divided into the Early Ceramic (AD 400-700) and Late Ceramic (AD 700-1300) periods (Lyndon 2005). The early Ceramic period in the Cohonina Area is coeval with the Basketmaker III Period of the Kayenta Area, and evidence of early Ceramic period use and occupation of the area is relatively sparse. Increasing settlement size and permanency, population size, and reliance on agriculture are all evident in the Late Ceramic Period (Sperinck 2009). Aggregated villages consisting of masonry room blocks are common. Ball courts, an architectural form common in the Hohokam Area to the south, also were introduced into the region and show the local participation in non-local social and ceremonial networks (Sperinck 2009). By the early AD 1200s, Cohonina populations abandoned the area, and the region was apparently uninhabited for more than a century (Schubert 2008).

The Ceramic Period for the Transition Zone is divided into three subperiods, following the cultural-historical framework of the Hohokam archaeological culture: the Early Ceramic Period (AD 200-600), the Pre-Classic Period (AD 600-1150), and the Classic Period (AD 1150-1450). Early ceramic period settlements in the Transition Zone reflect a seasonally based pattern, where people aggregated into small villages for the fall through the spring and then dispersed in the summer months into scattered agriculture-based farmsteads. Mobile populations, seasonally occupied pit houses, and a well-developed ceramic assemblage are all hallmarks of this early period. During the pre-Classic period, large Hohokam communities were established along the southern edge of the Transition Zone. Sites consist of many residential structures, trash mounds, and public architecture (Doyel 1986; Doyel and Elson 1985). Hohokam communities relied on an agricultural economy reflected in a variety of water-control features including canal systems that diverted water from major drainages. Pre-Classic period sites around Prescott and along the Agua Fria drainage represent a melding of cultural traits of local populations with Hohokam colonists from the south. By AD 1150, much of the Transition Zone experienced a dramatic decrease in population. This population decrease may have been the result of climatic changes and decreased rainfall, which led to decreases in agricultural productivity and profound social change. However, around AD 1200, Perry Mesa, between the New River drainage and the Prescott Valley, experienced a dramatic increase in population and the establishment of numerous habitation sites, many located near the edges of the mesa. This dramatic increase in population continued until the early 1400s, when Perry Mesa and the Transition Zone more generally experienced an equally dramatic population decline.

3.17.3.2.2.4 Late Prehistoric/Protohistoric Period

The Late Prehistoric/Protohistoric Period in the U.S. Southwest was a time of important cultural change. Major population movements and abandonments beginning ca. AD 1300 characterize much of the study area. The end of the Late Prehistoric/Protohistoric Period is defined by the arrival of the Spanish into the U.S. Southwest, but the dates for this incursion vary across the overall study area.

In the Kayenta Area, the Late Prehistoric/Protohistoric Period as defined here begins with the Pueblo IV Period, ca. AD 1275-1300, to the arrival of the Spanish ca. AD 1540-1600 (Adams and Duff 2004). The Pueblo IV Period was a time of extensive population dislocation, migration, and aggregation (Adams et al. 2004). Aggregated villages that characterized the Pueblo IV Period surpassed in size the largest of the Pueblo III Period settlements and these villages were almost always parts of larger settlement clusters (Adams and Duff 2004). The Hopi Mesas are located at the extreme southern end of Black Mesa. The villages of the Hopi are arranged in three main groups: First, Second, and Third mesas. Each Hopi Mesa is a distinct settlement cluster that consisted of a primary village associated with several smaller villages. A fourth settlement cluster centered around the Village of Awatovi is located on Antelope Mesa just southeast of First Mesa, but Antelope Mesa was abandoned after AD 1700 (Adams et al. 2004). The Hopi Mesas have been continuously occupied since ca. AD 1200 (Adams 1996).

After the post-1300 abandonment of large parts of the Kayenta Area by Anasazi/Ancestral Pueblo groups, Athabaskan-speaking groups arrived in the area. The exact timing of this arrival is debated, mostly because of a lack of archaeological data (Towner 1996), although most scholars believe that they arrived in the northern portion of the U.S. Southwest sometime between AD 1450 and 1500 (Wilshusen 2010). By AD 1600-1650, a distinct and identifiable Navajo culture emerged in the Dinétah, the Navajo homeland, located in northwestern New Mexico (Wilshusen 2010). By AD 1700, the Navajo occupation of Dinétah was well established, and the Navajo lived in forked-pole hogans and constructed masonry pueblitos; farmed maize, beans, and squash; and raised sheep, goats, and horses (Towner and Heckman 2011).

The Late Prehistoric/Protohistoric Period in the Southern Utah, Southeastern Nevada, and the Arizona Strip Area and the Las Vegas Area begins with the abandonment of the area by Anasazi/Ancestral Pueblo peoples. Historical accounts and archaeological evidence point to the occupation of these cultural-environmental areas by Patayan (ancestral Yuman) and Southern Paiute groups.

In the Cohonina area, archaeological evidence suggests a 100- to 200-year gap between the final Cohonina presence in the region (dated to ca. AD 1300) and the appearance of early northern Pai-speaking hunter-gatherer occupations. The Cohonina Area was used and occupied by several Native American groups during the Late Prehistoric/Protohistoric and Historical periods, including the Hualapai, the Havasupai, the Yavapai, the Navajo, and the Hopi.

Relatively little is known archaeologically of the Late Prehistoric/Protohistoric Period in the Transition Zone, and historical accounts indicate that the portion of the Transition Zone traversed by the NGS-KMC Project crosses through the traditional homeland of three Native American groups; the Hualapai, the Yavapai, and the O'odham (Fontana 1983; Khera and Mariella 1983; McGuire 1983).

3.17.3.2.2.5 Historic Period

The portions of the U.S. Southwest that are traversed by the study area share common elements of historical-period development. The entire region has been witness to numerous Spanish, Mexican, and American exploration efforts. Exploration began with early Spanish colonial forays of the mid-1500s and early 1600s, and though the Spanish utilized travel and supply routes through the region, they implemented only limited colonization efforts. Commercial trade on the routes was encouraged under Mexican rule in the 1800s.

Surveys and expeditions by the U.S. government in the last half of the 19th Century provided mapping and information critical for settlement in the American period. The establishment of local roads in the late nineteenth and early twentieth centuries was critical for the success of remote ranches, mines, and settlements. The growing population of the desert U.S. Southwest required an increasingly complex and dependable transportation system of roads, highways, and railroads linking water sources and connecting population centers. Similarly, electrical transmission lines and communication systems provided necessary infrastructure for the region where settlements were often separated by long distances and away from crucial resources.

Resource exploitation played a major role in the more recent history of the U.S. Southwest. Prospectors spread across the region in search of precious metals after the excitement of the California Gold Rush waned. Settlers took advantage of homestead laws enacted during the late 19th Century; consequently, most of the available arable land with water sources was appropriated. The earliest settlements were limited to areas with reliable water sources, but settlers learned to modify the landscape as well as traditional farming and ranching techniques to improve success under harsh conditions. Mormon colonies were formed in northern Arizona, southern Nevada, and southern Utah. The establishment of National Forests by the U.S. government and the rise of mining and timber industries fueled both economic and population growth throughout the larger region, facilitating ranching, farming and industry in remote areas. At the end of the 19th Century, regional ranching efforts expanded beyond a subsistence economy into commercial farming and stock raising. Increasingly complex water management developments in the late 1800s and early 1900s ranged from local work by irrigation cooperatives to federally-funded dams and hydroelectric plants.

The City of Las Vegas boomed following development of dependable water sources at the turn of the 20th Century, and later with electrical power supplied by completion of Hoover Dam in 1935. Tourism and recreation became an increasingly important part of the economy for the cultural-environmental areas intersected by the study area, including destinations such as the Grand Canyon, Las Vegas, and Lake Mead.

Despite conflicts with U.S. governmental policies, most regional Native American populations have retained their cultural identity and re-established aspects of their sovereignty as independent nations.

3.17.3.2.3 Federally Recognized Tribes

3.17.3.2.3.1 Land-owning Tribes

Elements of the proposed NGS-KMC Project are situated on or traverse portions of tribal land belonging to three federally recognized American Indian tribes: the Navajo Nation, the Hopi Tribe, and the Kaibab Band of Paiute Indians. In addition, the Moapa River Indian Reservation surrounds a portion of the WTS corridor that is managed by the BLM. The presence of archaeological sites, places of religious and cultural significance (TCPs), and human remains within the study area are potential cultural resource concerns for each tribal group.

3.17.3.2.3.2 Aboriginal Territories of Other Tribes

The extensive land use practices of the Zuni people, especially those related to religious practices and long-distance travel and trade, occurred within the traditional territories of the four land-owning tribes (Ferguson and Hart 1985). Although the Pueblo of Zuni does not have reservation land within the study area, TCPs for the Zuni people may be present in or adjacent to project features. Consequently, an ethnographic overview that addresses TCPs is being conducted to identify these places in advance of proposed project undertakings (i.e., at the proposed KMC) and routine O&M on other existing project facilities where no new construction or land disturbance is planned (i.e., NGS, BM&LP Railroad, WTS, STS, and communication sites). This investigation is being conducted in conjunction with the Zuni Tribal Historic Preservation Office.

The traditional territories of other Southern Paiutes Bands, including the San Juan, Kaiparowits, Uinkaret, Shivwits, Saint George, and Las Vegas bands, encompass the route of the WTS and its associated communication sites (Kelly and Fowler 1986). In addition, the traditional territories of other tribal groups, such as the Walapai (a.k.a. Hualapai; McGuire 1983) and Havasupai (Schwartz 1983), may overlap with that of the Southern Paiutes and include the land and TCPs near the WTS. The traditional territories of other federally recognized tribes, including two groups of Yuman speakers (Maricopa and Yavapai; Harwell and Kelly 1983; Khera and Mariella 1983), and the Phoenix-area Pima peoples (Fontana 1983), contain the route of the STS and related Communication Sites. As with the Zunis, none of these tribes own land within the project footprint, but TCPs important to each group may be present. An ethnographic overview that identifies TCPs important to tribal communities who claim connection to the land associated with the project features, especially high places on which Communication Sites exist, will begin in 2016. As with the Zuni study, this study will provide spatial information important to consider as part of O&M of existing project features.

3.17.3.3 Navajo Generating Station

3.17.3.3.1 Archaeological Resources

The cultural resources records search identified seven previous cultural resource investigations located within or intersecting the NGS and associated facilities (**Table 1-2**). For a detailed discussion of survey coverage of the NGS refer to the cultural resources records search report (Graves 2015). These prior investigations include both survey projects and a survey and excavation project conducted by the Museum of Northern Arizona from 1969 through 1971 of the NGS and the BM&LP Railroad (Stebbins 1982; Stebbins et al. 1986; Swarthout et al. 1986). The Museum of Northern Arizona railroad project surveyed “a 413 hectare plant site plus related facilities such as an ash disposal yard, access roads, a water pumping station, and a water pipeline” (Stebbins et al. 1986).

Four archaeological sites have been identified within the NGS and its immediate related facilities. One small site is located at the southern end of the lake pump road (**Figure 1-3**). No information concerning its archaeological-culture/cultural designation, NRHP-eligibility status, site type, or chronological period was found (Graves 2015). The three other sites were recorded by the 1969-1971 Museum of Northern Arizona survey and excavation project and are located within the ash-disposal area of the NGS. These are two excavated Pueblo II Period Anasazi sites (Stebbins et al. 1986) and one unexcavated early-20th Century Navajo site (Stebbins 1982). The term Anasazi is used here rather than Anasazi/Ancestral Pueblo because the NGS (including the BM&LP Railroad) is located on Navajo Nation land. The NRHP-eligibility status of these three sites is not known. The Museum of Northern Arizona also reported that no archaeological sites were encountered at the NGS plant and that three additional prehistoric sites were found “in ancillary facilities” (Stebbins et al. 1986). These three sites were reported to have been avoided by construction of the NGS and were not excavated. Descriptions of these sites and their locations are not included in the reports resulting from the Museum of Northern Arizona project (Stebbins et al. 1986; Swarthout et al. 1986).

The cultural resources records search identified nine previous investigations within or intersecting the BM&LP Railroad ROW that covered the majority of the footprint of this portion of the study area. This total includes the original survey and excavation of sites by the Museum of Northern Arizona from 1969 through 1971 within the ROW of the railroad before its construction (Stebbins 1982; Stebbins et al. 1986). Including the three sites reported to have been located within the NGS (see discussion above), 123 prehistoric sites and 48 Navajo sites were identified. Fifty-one of the 123 prehistoric sites (Stebbins et al. 1986; Swarthout et al. 1986) and 11 of the 48 Navajo sites (Stebbins 1982) were excavated.

Sixty archaeological cultural resources intersect or are contained within the BM&LP Railroad portion of the study area. This total does not include an additional 16 sites that were identified in the Museum of Northern Arizona records as being part of the original survey of the railroad ROW but lacked locational data (Graves 2015). Because the locations of these cultural resources and their current conditions are not known, they are not included here.

The archaeological sites identified within the BM&LP Railroad portion of the study area are comprised largely of Anasazi and historic Navajo sites (**Table 3.17-6**). Sixty-three percent of the sites in the BM&LP Railroad ROW are Anasazi sites or have an Anasazi component. Although most of the Anasazi sites are dated to the less specifically defined Ceramic Period, 11 Anasazi site records had sufficient description to permit these 11 sites to be assigned to either the Basketmaker periods or the Pueblo periods (**Table 3.17-6**). Approximately 26 percent of cultural resources in the BM&LP Railroad ROW are Historic Period Navajo sites or have a Historic Period Navajo component. No Paleoindian Period, Archaic Period, or Late Prehistoric/Protohistoric Period sites were identified. Anasazi sites in the BM&LP Railroad portion of the study area consist mainly of artifact scatters and artifact scatters with non-linear features that mostly represent the structural remains of habitation structures (**Table 3.17-7**). All of the identified Navajo sites contained features such as hogans, sweat lodges, and corrals (**Table 3.17-7**).

Table 3.17-6 Chronological Period of Archaeological Cultural Resources in the BM&LP Railroad Portion of the Study Area

	Archaeological Cultural Tradition (number of sites)				
Chronological Period	**Anasazi**	**Anasazi and Navajo**	**Navajo**	**Not Specified**	**Total**
Basketmaker Periods (Basketmaker II and/or Basketmaker III)	2	—	—	—	2
Basketmaker Periods and Pueblo Periods	1	—	—	—	1
Pueblo Periods (Pueblo I, Pueblo II, and/or Pueblo III)	8	—	—	—	8
Ceramic Period	25	—	—	2	27
Ceramic Period and Historic Period	—	2	—	—	2

Table 3.17-6 Chronological Period of Archaeological Cultural Resources in the BM&LP Railroad Portion of the Study Area

Chronological Period	Archaeological Cultural Tradition (number of sites)				
	Anasazi	Anasazi and Navajo	Navajo	Not Specified	Total
Unknown Prehistoric Period	—	—	—	1	1
Historic Period	—	—	14	2	16
Unknown	—	—	—	3	3
Total	36	2	14	8	60

Table 3.17-7 Archaeological Site Type of Archaeological Cultural Resources in the BM&LP Railroad Portion of the Study Area

Site Type	Archaeological Cultural Tradition (number of sites)				
	Anasazi	Anasazi and Navajo	Navajo	Not Specified	Total
Artifact(s)	7	—	—	1	8
Artifact(s) and non-linear feature(s)	7	1	4	—	12
Non-linear feature(s)	3	—	8	1	12
Linear feature(s)	—	—	—	1	1
Not enough information	19	1	2	5	27
Total	36	2	14	8	60

Only 2 of the 60 archaeological cultural resources identified in the BM&LP Railroad study area were identified as historic properties during the cultural resources records search. These are two Ceramic Period, Anasazi sites that were recommended eligible for listing in the NRHP by their site recorders. One is an artifact and non-linear feature site; the other is an artifact scatter site. Both sites are located along the eastern end of the railroad in the Klethla Valley, the area of the highest density of archaeological cultural resources along the BM&LP Railroad ROW. Both sites were excavated by the Museum of Northern Arizona survey and excavation project that was conducted prior to railroad construction. The portion of the artifact(s) and non-linear feature(s) site within the railroad ROW was excavated and no unequivocal archaeological features or undisturbed archaeological deposits were identified (Swarthout et al. 1986). The portion of the artifact scatter site within the railroad ROW was partially excavated and only buried artifacts were recovered (Swarthout et al. 1986).

3.17.3.3.2 Architectural Resources

No buildings, structures, or engineering features currently are considered historic properties within the NGS cultural resource study area, including the approximately 80-mile-long fenced corridor containing the BM&LP Railroad. Construction of these facilities began in 1969, and may be eligible for listing as elements of a historic district in the NRHP for their engineering and historical significance when they reach 50 years old.

3.17.3.3.3 Traditional Cultural Properties

No specific places of religious and cultural significance have yet been identified within the NGS study area. However, the Colorado River and San Juan River are considered to be TCPs by the Navajo Nation

(Keur et al. 2015; Martin 2002; Navajo Nation Historic Preservation Department-TCP files), and the nearby confluence of these two rivers, now submerged below Lake Powell, is especially meaningful (Linford 2000). Current and future TCP studies conducted for the Navajo Nation, Hopi Tribe, Pueblo of Zuni, and other tribes with traditional and on-going associations may reveal places of religious and cultural significance that need to be evaluated for their eligibility to the NRHP.

The cultural resources records search effort revealed that the Navajo Nation Historic Preservation Department Traditional Culture Program has identified a single TCP near Cow Springs, Arizona, that may partially intersect the railroad corridor; however, the mapped location was imprecise. On-going ethnographic investigations may confirm the location of this resource (Keur et al. 2015). It is described as a portion of a turquoise trading route, a migration route for certain clans, and a resting place for holy people.

3.17.3.4 Proposed Kayenta Mine Complex

The affected environment for archaeological resources is the entire proposed KMC, which includes the ongoing Kayenta Mine and the former Black Mesa Mine (**Figure 3.17-4**). The affected environment includes both the areas that have been disturbed by mining since the late 1960s and the undisturbed areas proposed for future mining.

Conducted from 1967 to 1987, the BMAP was one of the largest and longest-running archaeological projects in the U.S. Southwest. The BMAP was initiated when the Peabody Coal Company (now the PWCC) obtained a lease to extract coal from the northern end of Black Mesa. Early investigations were directed first by Robert C. Euler (1968) through Prescott College and Fort Lewis College. Later research was directed by George J. Gumerman (1969-1974), Stephen Plog (1975-1977), and Shirley Powell (1978-1987) through Southern Illinois University at Carbondale (Powell et al. 2002).

Over the course of the project, a survey was conducted of the entirety of both the former Black Mesa Mine and the Kayenta Mine, approximately 256 square kilometers or nearly 99 square miles (Powell et al. 1983; Powell and Gumerman 1990). Between 1968 and 1974, surveys were conducted in several areas in the western portion of the mining-lease area. This western lease area includes the former Black Mesa Mine and the northwestern portion of the Kayenta Mine, west of a line bisecting the N-11 Extension mine area. These early surveys of the western lease were conducted on relatively small areas where mining or other development was imminent; it may lack the precision and rigor of later BMAP surveys (Powell and Gumerman 1990). In 1975, a systematic, intensive survey of the entire eastern lease area, which totaled nearly 47 square miles (Powell and Gumerman 1990). From 1975 through 1979, survey of specific areas of the western lease area that were slated for immediate mining or development continued. In 1980, all undisturbed areas remaining in the western lease area were surveyed, whether they had been surveyed in previous field seasons or not. In addition, all non-lease lands between the western and eastern lease areas under Navajo jurisdiction were surveyed in 1980. Non-lease lands south of the Hopi-Navajo boundary under Hopi jurisdiction were not surveyed (Powell and Gumerman 1990).

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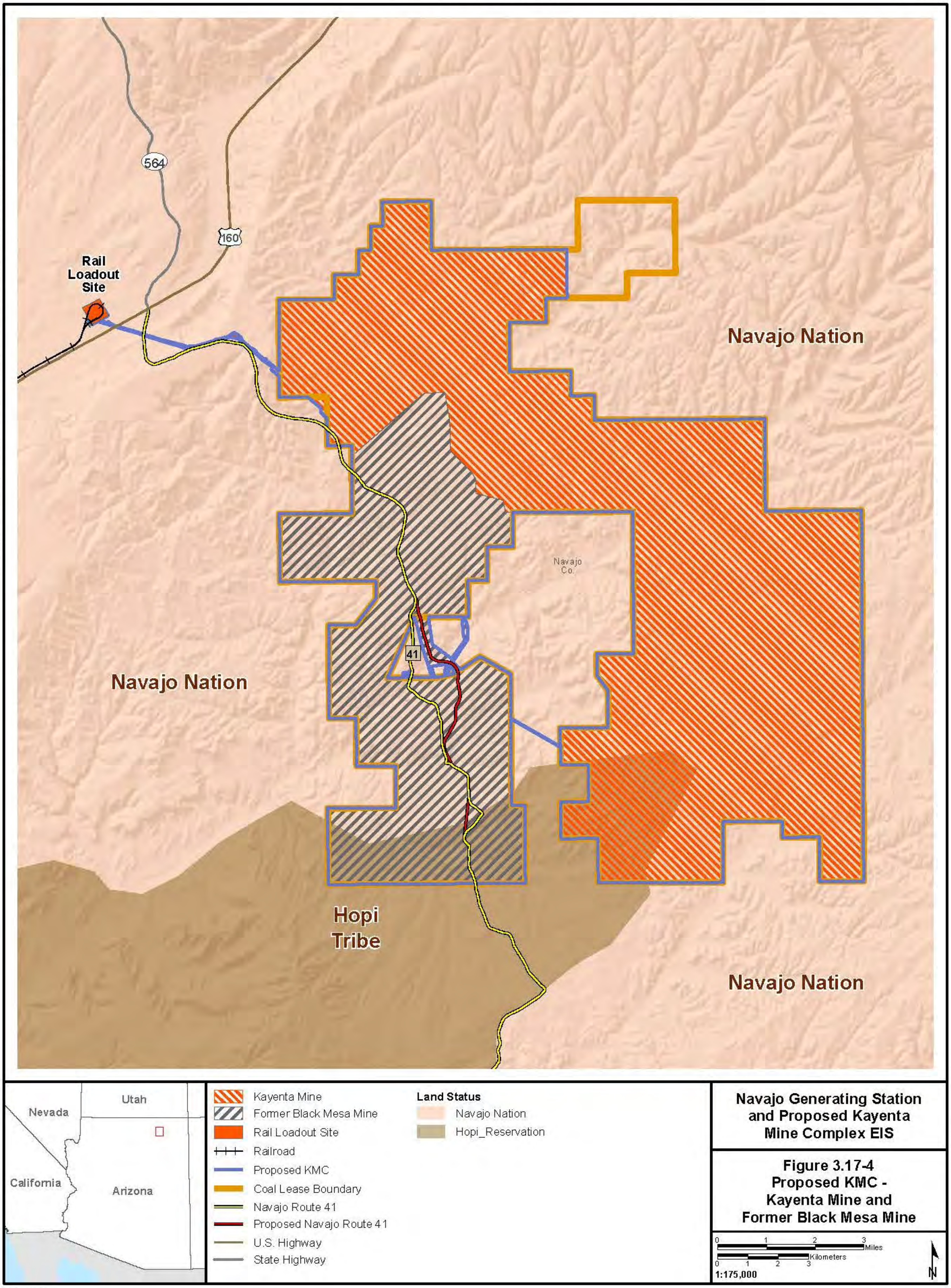

Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 3.17-4 Proposed KMC - Kayenta Mine and Former Black Mesa Mine

8/8/2016

According to published accounts, approximately 2,700 archaeological sites were identified and recorded by the BMAP (Graves 2015). Of these, between 166 and 188 Prehistoric sites and between 12 and 27 Historic Period sites were excavated (site frequency ranges reflect variation in reported site frequencies; Powell et al. 2002; Powell and Gumerman 1990; PWCC 2012 et seq.). Each year of the BMAP, the information obtained from survey and excavation were compiled into a descriptive report: 1968 (Gumerman 1970); 1969-1970 (Gumerman et al. 1972); 1971-1976 (Powell 1984); 1977 (Klesert 1978); 1978 (Klesert and Powell 1979); 1979 (Powell et al. 1980); 1980 (Andrews et al. 1982); 1981 (Smiley et al. 1983); 1982 (Nichols and Smiley 1984); and 1983 (Christenson and Parry 1985). Later, more-synthetic reports were published based on data from the BMAP (Blomberg 1983; Gumerman 1984; Parry and Smiley 1990; Powell 1983; Powell and Gumerman 1987; Powell and Smiley 2002; Powell et al. 1990a,b), as well as stone artifact (Green 1985; Parry and Christenson 1987), ceramic artifact (Smith 1994), and mortuary analyses (Martin et al. 1991).

Per approved SMCRA permit AZ-0001E, PWCC continues to 1) report the discovery of any previously unrecorded cultural resources to OSMRE and cease work near discoveries until OSMRE determines appropriate disposition, 2) identify and respectfully treat any human remains associated with archaeological sites, 3) take into account any sacred and ceremonial sites brought to the attention of PWCC by local residents, clans, or Tribal government representatives of the Hopi Tribe and Navajo Nation, and 4) sponsor ethnographic and TCP investigations in future disturbance areas (OSMRE 2011, 2008, 1990; PWCC 2012 et seq.).

PWCC provided archaeological site data for the cultural resources records search that included information and locational data for 2,761 sites identified by BMAP. These data were received in January 2014. Of the 2,380 archaeological sites discovered by BMAP in the overall permitted area and included in the PWCC data, 685 were located within the former Black Mesa Mine permit area, and 1,695 were located within the Kayenta Mine permit area. There are an additional 12 sites outside the permit areas but within the PWCC lease area. Prior actions for the former Black Mesa Mine include mining areas and infrastructure construction and operation (e.g., buildings, roads). Existing and current actions for the Kayenta Mine include all mining conducted since inception through 2019 and infrastructure construction and operation (e.g., buildings, roads, conveyors, storage sites) that historically has been used to support the Kayenta Mine. Some facilities constructed within the Black Mesa permit area are used for Kayenta Mine operations. **Table 3.17-8** provides a summary of the number of archaeological sites that have been progressively removed (or avoided) by mining within the former Black Mesa Mine and the Kayenta Mine. The cumulative effects of these past and present mining activities, combined with the Proposed Action mining activities, are further discussed under Section 3.17.4.

Table 3.17-8 Status of Cultural Resources Sites on Former Black Mesa Mine and Kayenta Mine Permit Areas

Site Status	Number of Sites[1]	
	Former Black Mesa Mine[2]	Kayenta Mine through 2019
Archaeological sites identified by BMAP	685	1,695
Number of archaeological sites removed by mining and support infrastructure[3]	139	766
Sites remaining	546	929

[1] Data are from the PWCC archaeological site data acquired for the cultural resources records search in January 2014. Data does not include the 12 sites located outside of the permit areas in Coal Mine Wash but within the PWCC lease area.

[2] Includes infrastructure that was constructed on the former Black Mesa Mine permit area that is still used on the Kayenta Mine.

[3] Includes sites identified as disturbed/mined out in the PWCC data and presumably include sites affected by mining activities and other infrastructure construction and operation (e.g., roads, buildings, conveyor systems, and storage areas).

Since the 1990s, in response to NAGPRA and Tribal legislation, PWCC has sponsored additional investigations at Prehistoric archaeological sites identified by the BMAP as having features with “a high potential to contain human burials” (PWCC 2012 et seq.). PWCC in consultation with the Navajo Nation and the Hopi Tribe developed a procedure to address the likelihood that human remains would be encountered in given archaeological contexts and historic settings. Between 1993 and 2014, 16 projects resulted in the investigation of 60 sites for the presence of human remains and burials (Ballagh et al. 1999a; Ballagh et al. 1999b; Bungart 1997, 2000; Geib and Spurr 2006; PWCC 2012 et seq.; Sandoval 2013b; Spurr 2014, 2006, 2002a, 1999, 1998, 1993; Spurr and Collette 2006; Spurr et al. 2013, 1998; Tsosie 2007). Of these 60 sites, 30 were found to contain human remains. When human remains were encountered, they were either recorded and reburied in locations that would not be disturbed by future mining-related activities (Ballagh et al. 1999a; Geib and Spurr 2006; PWCC 2012 et seq.; Spurr 2014, 2006, 2002a, 1999, 1998, 1993; Spurr and Collette 2006; Spurr et al. 2013, 1998) or fenced and avoided. The Tribes participated in the development of reburial protocols and gave their consent for reburial. These investigations complied with federal laws, including NAGPRA.

From 1994 through 2014, PWCC (2012 et seq.) also sponsored 21 projects within the Black Mesa and Kayenta Mines to identify and record TCPs in areas where mining activities were planned. TCPs are discussed in detail later in this section.

3.17.3.4.1 Data Quality Assessment Survey

The DQAS was conducted in September and October 2014, to survey areas proposed to be mined. Appendix A in Graves 2015, determine how accurately sites were recorded and plotted by BMAP, and determine if additional sites were now detectable. The surveyed locations were associated with the mine areas of the proposed KMC (J-19, J-21, J-21 West, N-10, and N-11 Extension [**Figure 3.17-2**]). Approximately 852 acres across 13 separate survey blocks were surveyed. The total surveyed area constitutes approximately 11 percent of the undisturbed acreage of the affected lands associated with the mine areas and only applied to areas proposed to be mined after 2019; all of the survey blocks had been previously surveyed by BMAP archaeologists.

Thirty-five archaeological sites were identified and recorded during the survey, 10 of which were newly discovered and recorded. The remaining 25 sites were previously recorded by BMAP in the 1970s. According to the site-location data received from PWCC, 31 sites were plotted within the survey blocks. Ten of these sites were found to be not located within the surveyed areas and, in most cases, were just outside of survey blocks covered by the DQAS. The remaining 21 were relocated and re-recorded. Four additional sites recorded by BMAP and plotted outside of the survey blocks in the PWCC site-location data were found to be located within the survey blocks investigated and were re-recorded. Seven of the 25 sites encountered that were previously identified and recorded by the BMAP also had been previously excavated or partially excavated during the BMAP. PWCC operations are in compliance with Chapter 13 of the currently approved Permit Application Package (PWCC 2012 et seq.), which addresses cultural resources.

The original recordings of sites conducted by BMAP in the survey areas were done to high professional standards and were comprehensive in their descriptions. The discovery of newly recorded sites and the inaccurate plotting of some previously recorded sites does not reflect negatively on the quality of site recording or the field methods of BMAP. Rather, their discovery reflects improvements in archaeological detection and recording methods since the 1970s and 1980s and contemporary archaeologists’ access to new technologies such as global positioning systems and geographic information systems that more accurately record site locations and site boundaries.

In addition, 62 isolated artifacts, small sets of artifacts, and features were encountered and recorded. Two of the isolates may represent culturally significant features or potential TCPs. These include a culturally modified juniper tree on Navajo Nation land and a potential shrine located on Hopi land (Graves 2015).

Based on the results of the DQAS, new intensive, pedestrian ground surveys will be conducted of all areas proposed for mining (Section 3.17.3.1, Data Collection). These surveys are to be conducted in 2016.

3.17.3.4.2 Archaeological Cultural Resources and Historic Properties

A total of 224 archaeological cultural resource sites were identified by the cultural resources records search and the survey (**Table 3.17-9**). This total excludes those sites already removed by mining and support infrastructure (**Table 3.17-8**). No sites were recorded within the corridors of the two proposed reroute segments of Navajo Route 41 because these areas were previously mined (**Table 3.17-9**). Of the 224 sites identified, 214 were identified as being recorded by BMAP. The remaining 10 sites were newly recorded by the DQAS: 4 in J-21, 4 in J-21 West, and 2 in N-10 (Graves 2015). Given the issue of accuracy in the plotting of previously recorded sites in the proposed KMC, no attempt was made to remove the previously recorded BMAP sites from the total of 214 sites identified in the cultural resources records search.

Table 3.17-9 Data Quality Assessment Survey Results

Mine Component	Archaeological Sites	Eligible Archaeological Sites[1]	Comments
J-19	1	1	—
J-21	14	9	4 of the 14 sites were newly recorded
J-21 West	118	112	4 of the 118 sites were newly recorded
N-10	24	17	2 of the 24 sites were newly recorded
N-11 Extension	67	63	—
Navajo Route 41 Proposed Re-Route Corridors	0	0	—
Total archaeological cultural resources	*224*	*202*	—

[1] Includes those archaeological sites with NRHP status of "determined eligible" or "recommended eligible" in the cultural resources records search (Graves 2015). The NRHP-eligibilities of the 10 newly recorded sites were not evaluated.

Land and facilities affected by prior actions in the proposed KMC and the archaeological cultural resources identified in these locations are listed in **Table 3.17-10**. **Table 3.17-10** does not include sites identified as being removed by mining and support infrastructure (**Table 3.17-8**). Forty-four archaeological sites have been identified within lands in J-19, J-21, and N-9 that will be impacted prior to 2020. Of these 44 sites, 41 have been identified as historic properties. Twelve sites have been identified by the cultural resources records search study as being located within the footprints of the Mesa Central Complex, the N-11 facilities, the Reclamation Complex, and the Silo Complex; and 6 sites have been identified within the conveyor belt corridor. Of these 18 sites, 5 have been identified as historic properties. Any lands impacted prior to 2020 are covered under existing permits and on-going authorizations.

The archaeological cultural resources located within the proposed KMC are either: 1) Anasazi or Ancestral Pueblo sites that date to the Basketmaker and/or Pueblo periods or the more general Ceramic period; or 2) Historical period Navajo sites (**Table 3.17-11**). All archaeological sites identified as Anasazi are located on Navajo Nation lands, and all archaeological sites identified as Ancestral Pueblo are located on Hopi Tribal lands (**Figure 3.17-2**). The majority of Anasazi and Ancestral Pueblo sites contain either artifacts only or combinations of both artifacts and features such as subterranean pit structures or kivas, aboveground storage and habitation rooms, and/or pits or cists. Historic Period Navajo sites consist of either combinations of artifacts and features (such as hogans, corrals, or sweat lodges) or features without surface artifacts.

Approximately 90 percent of the archaeological cultural resources located within the proposed KMC were identified in the cultural resources records search as historic properties (**Tables 3.17-8** and **3.17-9**). That is, the data compiled during the inventory describe these sites as being either determined or recommended NRHP eligible.

Table 3.17-10 Archaeological Cultural Resources within Lands Affected by Prior Actions in the Proposed KMC

Mine Component	Number of Archaeological Sites	Eligible Archaeological Sites[1]
Lands Impacted Prior to 2020		
J-19	7	7
J-21	26	25
N-9	11	9
Facilities		
Airport	0	0
J-28 Facilities	0	0
Mesa Central Complex	2	0
N-11 Facilities	2	1
N-14 Facilities	0	0
N-8 Facilities	0	0
PWCC Trailer Park	0	0
Reclamation Complex	2	2
Silo Complex	6	0
Conveyor Belt Corridor	6	2
Total archaeological cultural resources	62	46

[1] Includes those archaeological sites with NRHP status of "determined eligible" or "recommended eligible" in the cultural resources records search (Graves 2015).

Table 3.17-11 Archaeological Cultural Resources within the Proposed KMC

Cultural Tradition	Chronological Period	Archaeological Site Type
Anasazi (n = 79)	Basketmaker Periods (Basketmaker II and/or Basketmaker III) (n = 16)	Artifact(s) (n = 109)
Ancestral Pueblo (n = 104)	Basketmaker Periods and Pueblo Periods (n = 9)	Artifact(s) and non-linear feature(s) (n = 100)
Historic Period Navajo (n = 38)	Pueblo Periods (Pueblo I, Pueblo II, and/or Pueblo III) (n = 150)	Non-linear feature(s) (n = 11)
Not specified (n = 3)	Ceramic Period (n = 8)	Not enough information (n = 4)
—	Historical Period (n = 39)	—
—	Unknown Period (n = 2)	—

Note: Frequencies of sites assigned to each value are shown in parentheses. These frequencies represent the total number of sites in areas proposed for mining: J-19, J-21, J-21W, N-10, and N-11 Extension.

3.17.3.4.3 Architectural Resources

No buildings, structures, or engineering features currently are considered historic properties within the 62,930-acre proposed KMC area, including the coal conveyor system and the coal silo facilities. One or more resources may become eligible as elements of a historic district for listing in the NRHP for their engineering and historical significance when they reach 50 years old. A list of facilities appended to the KMC Programmatic Agreement provides a partial list of buildings and structures that, upon reaching 50 years of age, will require evaluation for the NRHP. Their known construction ages range from 1973 to 2005, with more than half of these structures constructed after 1983.

3.17.3.4.4 Traditional Cultural Properties

Efforts to identify TCPs within the Kayenta Mine permit area began in 1994 (Bungart and Livingston 1994a,b) and have continued to the present. When land-disturbance is anticipated, PWCC contracts with ethnographers and archaeologists to investigate specific localities for the presence of places of religious and cultural significance. When such places are identified, local residents are consulted regarding the age, function, and continuing importance of the places. Some of these places are largely unaltered landscape features associated with religious and traditional practices of individuals, families, communities, and clans. Other places are locations of recognizable past or present human activity associated with one or more of these entities (Martin n.d.).

TCPs that appear to be unaltered natural features within the permit area include places associated with events connected to supernatural beings, where resources (e.g., plants, soils, minerals, water) are collected, where offerings are made, and places that have played a part in the life-cycle of an individual (e.g., where a newborn child's umbilical cord is placed). Through consultation with local residents, a number of hills and high points, springs, and ponds; a hawk nesting place; and a lightning-struck tree have been identified as places of traditional and on-going cultural importance. Many of these places are used in conjunction with specific rituals and ceremonies.

TCPs that are places of past or present activity within the proposed KMC include archaeological sites where ancestors once resided and still maintain a spiritual presence as well as a variety of contemporary blessed places. Among these blessed places are hogans, houses, sweat lodges, ramadas, cornfields, domestic animal and game corrals, and trail shrines.

To date, at least 52 places of religious and cultural significance to local individuals and families have been identified within the proposed KMC between 1994 and 2014 (Bungart and Livingston 1994a,b; Dongoske 2001, 1998a,b; Sandoval 2013a,b, 2012, 2011, 2003a,b; Sandoval and Begay 2006; Sandoval et al. 2002; Spurr 2002a, 1998; Spurr and Two Bears 2003; Spurr et al. 2004; Tsosie 2007, 2005; Warburton 1997; Yazzie 2000). However, not all identified places were deemed worthy of in-place protection.

3.17.3.4.5 Human Burials

Historic Period human burials also are places of religious and cultural importance; their importance and treatment is culturally specific. The Navajo Nation refers to gravesites, human remains, and funerary items as *Jishchaa'* and has developed specific guidelines and policies related to the discovery and treatment of human remains and burials. The Hopi Tribe also has specific protocols for addressing the discovery of human remains. To date, the recovery, discovery, and treatment of human remains has been addressed on a case-by-case basis. Some human remains have been relocated after their recovery, and others have been left in place and protected from mining-related activities.

Within the proposed KMC, efforts to locate, record, disinter, and respectfully rebury human remains in new locations where they would not be disturbed in the future began in 1993 (Spurr 1993). At least 96 deceased individuals were identified within the permit area between 1993 and 2014

(Ballagh et al. 1999a,b; Bungart 2000, 1997; Geib and Spurr 2006; Spurr 2014, 2006, 2002a, 2002b, 1999, 1998, 1993; Sandoval 2003a,b; Spurr and Collette 2006; Spurr et al. 2013, 1998; Tsosie 2007).

Twenty-four TCPs, including places with known or expected human burials, are located within or adjacent to mine areas J-19, J-21, J-21 West, and N-9 (**Table 3.17-12**). This does not include Black Mesa itself as a TCP (Keur et al. 2015; Linford 2000; Martin n.d.; Sandoval and Begay 2006). On-going ethnographic work for the Navajo Nation, the Hopi Tribe, and the Pueblo of Zuni may result in the identification of additional TCPs in and near these same proposed mine areas.

Black Mesa as a topographic feature is a TCP. The Navajo Nation includes Black Mesa (Dzł yíjiin) as belonging to a TCP category that includes sacred/offering places and landscapes (Martin n.d.). Black Mesa is understood to be a female mountain (bi'áádii) that symbolizes feminine attributes and imparts this female quality to the wildlife, plants, minerals, and other resources found on this landscape feature (Martin n.d.). For the Navajo Nation, Black Mesa also is a widely acknowledged TCP within the larger Navajo TCL. On-going ethnographic work within the proposed KMC will contribute to the evaluation of Black Mesa itself as a TCP.

Table 3.17-12 Known TCPs and Human Burials Within or Near Proposed KMC Mine Areas

Mine Area	TCPs and Human Remains[1]	Source
J-19	1 (burial)	Bungart 1997
J-21	11 (ceremony sites, offering sites [including 2 archaeological sites], trail shrine, lightning struck trees, isolated burial, and 2 family cemeteries)	Sandoval 2013b; Spurr 2014, 1998, 1997; Spurr et al. 2004; Tsosie 2007
J-21 West	9 archaeological sites likely to contain human remains, at least 3 of these 9 contain village shrines considered TCPs	Dongoske 2001
N-9	3 (2 offering and collection places, 1 hawk nesting place)	Sandoval 2003b; Tsosie 2005
N-10	None as of 2014	—
N-11 Extension	None as of 2014	—

[1] The Navajo Nation does not consider human remains, burials, or other *Jishchaa'* to be cultural resources or TCPs.

3.17.3.5 Transmission Systems and Communication Sites

3.17.3.5.1 Western Transmission System

3.17.3.5.1.1 Archaeological Resources

Two hundred and thirty-two prior cultural resource investigations have been carried out within or intersecting the WTS (Graves 2015). Two of the earliest projects along the WTS are the surveys and excavations conducted for the original construction of the transmission line in Arizona, Utah, and Nevada, which was originally called the Navajo-McCullough Transmission Line. In 1971 and 1972, the Nevada Archaeological Survey at the University of Nevada, Las Vegas, conducted survey and excavations in the portion of the transmission line ROW in Nevada (Brooks et al. 1975). In all, 92 sites were recorded on the survey (Brooks et al. 1975). These consisted of Anasazi/Ancestral Pueblo, Paiute, and Lower Colorado River (i.e., Patayan or Yuman) and Historic Period non-Native American sites. Of these sites, 15 were excavated (Brooks et al. 1975). Work along the Arizona and Utah portion of the Navajo-McCullough Transmission Line was conducted by the Museum of Northern Arizona from 1972 through 1974 (Moffitt et al. 1978). Sixty-two sites were recorded in Arizona and Utah. These resources consist of Virgin Anasazi/Ancestral Pueblo, Kayenta Anasazi/Ancestral Pueblo, and Southern Paiute sites. Of these 62 sites, 32 were fully or extensively excavated.

Despite the extensive prior cultural-resources work conducted along the transmission line ROW, nearly 30 percent of the WTS has not been surveyed for cultural resources (Graves 2015). The pedestrian resurvey of the WTS completed in 2016 will fill gaps in data and provide a more complete view of the nature and distribution of cultural resources in this portion of the study area.

Prior to the resurvey, 129 archaeological cultural resources were identified as being located within or intersecting the WTS (Graves 2015; **Table 3.17-13**). Most of these are located in the portion of the WTS that falls into the southern Utah, southeastern Nevada, and Arizona Strip Area. This area has a higher density of cultural resources than the adjacent Las Vegas Area (Graves 2015). Only a small portion of the WTS lies within the Kayenta Area (**Figure 3.17-3**).

Table 3.17-13 Archaeological Cultural Resources Along the Western Transmission System

Cultural-Environmental Area	Number of Properties		
	Historic	Non-historic	Total
Las Vegas Area	18	17	35
Southern Utah, Southeastern Nevada, and the Arizona Strip Area	23	70	93
Kayenta Area	1	-	1
Total	42	87	129

The majority of archaeological cultural resources identified within or intersecting the WTS date to the Prehistoric Period (**Table 3.17-14**). Thirty-two sites date to the Historic Period or have a Historic Period component, and only 13 sites date to the Ceramic Period. In terms of archaeological site type, the most common types along the WTS are those that consist of artifacts only or artifacts and non-linear features (**Table 3.17-14**). The majority of these are from the Prehistoric Period. Sixteen sites that consist of or contain linear features also were located along the WTS. These sites date primarily to the Historic Period and consist of transmission lines, railroads, canals, roads, and trails. Three sites consist of or contain rockshelters (**Table 3.17-14**). Two of these rockshelter sites are located in Utah and one in Nevada. Only 6 of the 129 sites had information concerning archaeological culture or cultural affiliation. These six were Ceramic Period sites identified as Anasazi/Ancestral Pueblo sites and are located in Nevada and Arizona.

Table 3.17-14 Chronological Period of Archaeological Cultural Resources Along the Western Transmission System

Site Type	Period (number of sites)					
	Ceramic Period	Unknown Prehistoric Period	Unknown Prehistoric Period and Historic Period	Historic Period	Unknown	Total
Artifact(s)	6	59	5	1	—	71
Artifact(s) and non-linear feature(s)	5	10	4	3	—	22
Non-linear feature(s)	—	—	—	1	1	2
Linear feature(s)	—	—	1	8	—	9
Linear feature(s) and artifact(s)	—	1	1	5	—	7
Rock shelter	—	—	—	—	1	1

Table 3.17-14 Chronological Period of Archaeological Cultural Resources Along the Western Transmission System

Site Type	Period (number of sites)					
	Ceramic Period	Unknown Prehistoric Period	Unknown Prehistoric Period and Historic Period	Historic Period	Unknown	Total
Rock shelter and artifact(s)	2	—	—	—	—	2
Not enough information	—	1	—	3	11	15
Total	13	71	11	21	13	129

Of the 129 identified cultural resources within or intersecting the WTS, 42 (or 33 percent) were identified as historic properties; that is, they were identified as being determined or recommended eligible for listing or are listed in the NRHP (**Table 3.17-15**). Identified historic properties are not distributed evenly across the WTS; half of the sites in the Las Vegas Area were identified as being historic properties, while only approximately one-quarter of the cultural resources within the Southern Utah, Southeastern Nevada, and the Arizona Strip Area were identified as such (**Table 3.17-15**). Over half of the historic properties identified in the WTS date to the Prehistoric Period, while approximately one-quarter date to the Historic Period (**Table 3.17-15**). Nearly 70 percent of the historic properties within or intersecting the WTS consists of artifacts and non-linear features. Eight of the 16 sites that consist of or contain linear features and one of the three sites that consist of or contain a rockshelter were identified as historic properties (**Tables 3.17-14** and **3.17-15**).

Table 3.17-15 Historic Properties Along the Western Transmission System

Site Type	Period (number of sites)				
	Ceramic Period	Unknown Prehistoric Period	Unknown Prehistoric Period and Historic Period	Historic Period	Total
Artifact(s)	1	10	3	—	14
Artifact(s) and non-linear feature(s)	3	7	3	1	14
Non-linear feature(s)	—	—	—	1	1
Linear feature(s)	—	—	—	5	5
Linear feature(s) and artifact(s)	—	1	1	1	3
Rock shelter and artifact(s)	1	—	—	—	1
Not enough information	—	1	—	3	4
Total	5	19	7	11	42

Only 2 of the 42 archeological cultural resources identified as historic properties along the WTS in the cultural resources record search are counted among the sites reported as being excavated in the original survey and excavation projects conducted before the construction of the transmission line (Brooks et al. 1975; Moffitt et al. 1978). These two sites were excavated along the Nevada portion of the WTS, and both date to the unknown Prehistoric Period in the cultural resources records search. One was described as being determined eligible and the other as being recommended eligible.

One of the historic properties in the WTS is a segment of the Old Spanish Trail in Nevada. The Old Spanish Trail is listed in the NRHP as a historic district (McBride and Rolf 2001). However, the segment of the Old Spanish Trail that intersects the WTS is identified as being recommended eligible for listing in the NRHP (Graves 2015) and is not a contributing element to the NRHP-eligibility of the overall property. This segment of the Old Spanish Trail intersects the WTS in three places between the Town of Moapa and Interstate 15 in the Dry Lake Valley. Two of the intersections of the Old Spanish Trail with the WTS occur on the Moapa River Indian Reservation, and the third intersection occurs just south of the reservation at the Crystal Substation.

3.17.3.5.1.2 Architectural Resources

No buildings, structures, or engineering features currently are considered historic properties within the 274-mile-long corridor containing the WTS.

3.17.3.5.1.3 Traditional Cultural Properties

Although the Gypsum Cave site lies outside the WTS corridor, the boundary established for it as a TCP intersects the WTS corridor. No other places of religious or cultural significance have been identified to date within or adjacent to the WTS land corridor. However, the transmission line does cross the Colorado River, which is considered to be a TCP by the Navajo Nation (Navajo Nation Historic Preservation Department-TCP files; Keur et al. 2015; Martin n.d.), among other indigenous tribes of the U.S. Southwest. On-going and future TCP studies conducted for the Navajo Nation, Hopi Tribe, Pueblo of Zuni, and other Tribes regarding the landscape encompassing the WTS may reveal places of religious and cultural significance that need to be evaluated for their eligibility to the NRHP.

3.17.3.5.2 Southern Transmission System

3.17.3.5.2.1 Archaeological Resources

The cultural resources records search revealed that 187 prior cultural resources investigations intersected or were carried out within the STS (Graves 2015). Of these, two investigations focused on nearly the entirety of the transmission line ROW. A survey and excavation project of the transmission line corridor from the NGS to the Westwing substation was conducted before the construction of the STS. Fieldwork was carried out from 1970 through 1973 by the Museum of Northern Arizona (Fiero et al. 1980). A total of 88 sites were identified, and 20 of these 88 sites were excavated. The excavated sites were all prehistoric and consisted of Kayenta, Cohonina, Perry Mesa tradition, and Agua Fria tradition sites (Fiero et al. 1980). In 2007 and 2008, a Class III survey of the STS was conducted along a corridor centered on the midline between the two transmission lines from the NGS to the Westwing substation (Bild et al. 2011; Laurila et al. 2011a, 2011b). In all, 262 cultural resources and 2 in-use Navajo sites were identified and recorded. Of these 262 sites, 79 were previously recorded and 183 were newly recorded (Bild et al. 2011; Laurila et al. 2011a, 2011b). Most of the sites identified and recorded by the Museum of Northern Arizona in the early 1970s were relocated during the 2007 and 2008 survey (Bild et al. 2011; Laurila et al. 2011a).

Three hundred-twenty archaeological cultural resources were identified within or intersecting the STS (**Table 3.17-16**). Frequencies of identified cultural resources are greater in the Cohonina area and the Transition Zone than they are in the portion of the STS that traverses the Kayenta area.

Table 3.17-16 Archaeological Cultural Resources Along the Southern Transmission System

Cultural-Environmental Area	Number of Properties		
	Historic	Non-historic	Total
Kayenta Area	40	29	69
Cohonina Area	56	47	103
Transition Zone	60	88	148
Total	156	164	320

The STS corridor contains a more diverse set of cultural resources than the other project features because of the variety of natural landscapes and culture areas it traverses. Thirteen different individual archaeological cultural traditions (excluding unknown) were identified for 253 of the 320 sites along the STS. Thirty-nine of the 253 sites were multiple component sites with two or more different archaeological cultural traditions assigned. The most numerous cultural resources within the STS in terms of archaeological cultural traditions are single component sites identified as Cohonina, Central Arizona tradition, Euroamerican, Navajo, Anasazi, or Salado. The term Anasazi is used here rather than Anasazi/Ancestral Pueblo because these sites are all located on Navajo Nation land (Graves 2015). All but 15 of the 320 archaeological sites along the STS had information allowing them to be assigned to one or more chronological periods. Thirty-five sites were multiple component sites with two or more different chronological periods assigned. The most numerous cultural resources within the STS in terms of chronological period are sites assigned to the Ceramic Period and sites that date to the Historic Period.

Thirteen different archaeological site types were identified among the 320 sites along the STS (Graves 2015).The most numerous site types are those identified as artifacts or artifacts and non-linear features. Twelve sites along the STS consist of or include rock-art images. All 12 date to the Ceramic Period, have a Ceramic Period component, or are dated less specifically to the Prehistoric Period. Four sites along the STS include rockshelters. Three of these sites are in the Cohonina Area, and one is in the Transition Zone. Rockshelters were identified only at sites that date to the Ceramic Period or have a Ceramic Period component.

Of the 320 archaeological cultural resources identified within or intersecting the STS, nearly half are identified as historic properties in the cultural resources records search. Of these 156 historic properties, the majority (151) were identified as recommended eligible for listing in NRHP. Three sites were identified as having been determined eligible for listing in the NRHP.

The 156 archaeological cultural resources within the STS corridor that have been identified as historic properties are similarly diverse in terms of archaeological cultural tradition, chronological period, and site type as the entire set of 320 identified resources. Relatively high percentages of Ceramic Period and Historic Period sites identified along the STS are historic properties. None of the sites of unknown chronological period were identified as historic properties along the STS.

Two properties listed in the NRHP intersect the STS in the Cohonina Area: the Grand Canyon Railway district and the Ash Fork Hill segment of U.S. Route 66. The rail line of the Grand Canyon Railway crosses the WTS north of Williams, Arizona. A portion of U.S. Route 66 that is listed in the NRHP intersects the STS west of Williams. This abandoned Ash Fork Hill segment of U.S. Route 66, crosses the STS in two segments, one just north of Interstate 40 and the other within the existing ROW of the Interstate 40. The Ash Fork Hill segment of U.S. Route 66 dates to the period 1921 to 1944 and is listed in the NRHP under Criteria A and C (Cleeland 1989).One other segment of U.S. Route 66 also crosses the STS just north of Interstate 40. However, the NRHP eligibility of this segment has not been evaluated, and it is not considered a historic property.

3.17.3.5.2.2 Architectural Resources

No buildings, structures, or engineering features currently are considered historic properties within the 257-mile-long corridor containing the STS.

3.17.3.5.2.3 Traditional Cultural Properties

To date, only a handful of places of religious or cultural significance have been identified near the STS corridor (**Table 3.17-17**). No TCPs have been identified within the corridor ROW. On-going and future TCP studies conducted for the Navajo Nation, Hopi Tribe, Pueblo of Zuni, and other tribes regarding the landscape encompassing the STS may reveal places of religious and cultural significance that need to be evaluated for their NRHP eligibility.

Table 3.17-17 Existing and Potential TCPs near the Southern Transmission System ROW

Existing or Potential TCP	Reference
Echo Cliffs. Place associated with hunting, traditional ceremonial history, game trails, and travel across	Navajo Nation Historic Preservation Department-TCP files; Keur et al. 2015
Gap in Echo Cliffs	Navajo Nation Historic Preservation Department-TCP files; Keur et al. 2015
Unnamed feature on Addition Hill	Navajo Nation Historic Preservation Department-TCP files; Keur et al. 2015
Copper Mine south of Page; place considered to be the "earbob" of the earth figure	Navajo Nation Historic Preservation Department-TCP files; Keur et al. 2015
Unnamed feature east of Cameron along Little Colorado River	Navajo Nation Historic Preservation Department-TCP files; Keur et al. 2015
Unnamed feature between Page and Cameron	Navajo Nation Historic Preservation Department-TCP files; Keur et al. 2015

3.17.3.5.3 Communication Sites

3.17.3.5.3.1 Archaeological Resources

The cultural resources records search identified 37 previous cultural resources investigations within or intersecting 9 of the 15 external communication sites (**Table 3.17-18**). These previous investigations cover approximately one-third of the acreage encompassing the 15 external communication sites (Graves 2015).

Table 3.17-18 Locations of Previous Cultural Resources Investigations at External Communications Sites

External Communication Sites with Previous Investigations	External Communication Sites with No Previous Investigations
Western Transmission System Communication Sites:	
Apex Peak (includes Powerline ROW)	Red Mountain
Glendale	Pipe Springs
Beaver Dam	
Buckskin Mountain	
Glen Canyon	

Table 3.17-18 Locations of Previous Cultural Resources Investigations at External Communications Sites

External Communication Sites with Previous Investigations	External Communication Sites with No Previous Investigations
Southern Transmission System Communication Sites:	
Jack's Peak	Zilnez Mesa
Preston Mesa	Mt. Francis
Mount Elden	White Tanks
Bill Williams Mountain	West Phoenix

Nine archaeological cultural resources were identified in the footprints of four external communication sites (**Table 3.17-19**; Graves 2015). Three sites are located within the study areas of two WTS communication sites: Apex Peak and Buckskin Mountain. Six sites were identified in the study areas of two STS communication sites: Mount Elden and Bill Williams Mountain. Only one of the nine sites was identified as a historic property. This site is located on the Buckskin Mountain communication site and was recommended eligible for listing in the NRHP (**Table 3.17-19**). The cultural resources records search did not identify information suggesting that any of these sites may have been destroyed by communication site construction or operations. Consequently, they are assumed to be still in existence.

Table 3.17-19 Archaeological Cultural Resources at External Communication Sites

Communication Site	Description	NRHP-Eligibility Status
Apex Peak	Prehistoric period rockshelter and artifact(s) site; unknown archaeological-culture/cultural designation	Not evaluated
	Prehistoric period artifact(s) site containing lithic artifacts; unknown archaeological-culture/cultural designation	Recommended not eligible
Buckskin Mountain	Prehistoric period artifact(s) site consisting of lithic artifacts; unknown archaeological-culture/cultural designation	Recommended eligible
Mount Elden	Nonlinear feature(s) site that consists of, or includes, a depression; unknown age and unknown archaeological-culture/cultural designation	Unknown
	Historical period nonlinear feature(s) site consisting of, or including, a cabin; unknown archaeological-culture/cultural designation	Unknown
Bill Williams Mountain	Euroamerican nonlinear feature(s) site described as a government tower	Unknown
	Historical period Euroamerican linear feature(s) site	Unknown
	Historical period site; unknown site type and unknown archaeological-culture/cultural designation	Unknown
	Historical period site; unknown site type and unknown archaeological-culture/cultural designation	Unknown

3.17.3.5.3.2 Architectural Resources

No buildings, structures, or engineering features are currently considered historic properties within the study areas of any of the communication sites.

3.17.3.5.3.3 Traditional Cultural Properties

Places of religious and cultural significance have been identified within or adjacent to several of 15 external communication sites. Bill Williams Mountain, Glen Canyon/Lake Powell, and Zilnez Mesa have been cited by Linford (2000) as places of religious and cultural significance to the Navajo Nation. Mount Elden and Preston Mesa have been recorded as TCPs by the Navajo Nation Historic Preservation Department Traditional Culture Program (**Table 3.17-20**). Bill Williams Mountain also is a place of geographic importance to the Hopi Tribe (Ferguson et al. 1993) and to the Havasupai and Yavapai-Prescott tribes (Lane 2003). On-going and future TCP studies conducted for the Navajo Nation, Hopi Tribe, Pueblo of Zuni, and other Tribes regarding the geographic features on which the communication sites have been built may reveal places of religious and cultural significance that need to be evaluated for their eligibility to the NRHP.

Table 3.17-20 Existing and Potential TCPs at or Near External Communication Sites

Communication Site	Existing or Potential TCP	Reference
Bill Williams Mountain	Navajo TCP. Place associated with Navajo Blessingway Chant; place marking one of the margins of the Hopi heartland and a location associated with migration stories and plant-gathering activities (*Hopi Tutsqwa*); place also important to Hualapai and Yavapai-Prescott people.	Navajo Nation Historic Preservation Department-TCP files; Keur et al. 2015; Ferguson et al. 1993; Linford 2000
Glen Canyon/Lake Powell	Navajo TCP. Place where male-gendered San Juan River joins the female-gendered Colorado River is a very sacred location. The Colorado River is a widely accepted TCP for many tribes.	Linford 2000; Martin n.d.
Mount Elden	Navajo TCP. Elden Spring and Mount Elden; Elden Spring is near the Mount Elden Communication site. Mount Elden is a place associated with ceremonial stories and clan histories associated with Western Water Clan.	Navajo Nation Historic Preservation Department-TCP files; Keur et al. 2015
Preston Mesa	Navajo TCP. Preston Mesa is the location of hunting grounds, prehistoric sites, a location associated with ceremonial stories, and a location for storing ceremonial items.	Navajo Nation Historic Preservation Department-TCP files; Keur et al. 2015
Zilnez Mesa	Navajo traditional wild plant gathering location.	Linford 2000

3.17.3.6 Summary

Information derived from the cultural resources records search and the DQAS identified a total of 825 intact archaeological cultural resources within the entire study area (**Table 3.17-21**). In addition, 28 TCPs are known from the literature review and records search to be within or near the overall project footprint that comprises the entire study area. On-going and future TCP studies conducted for the Navajo Nation, Hopi Tribe, Pueblo of Zuni, and other tribes may reveal additional places of religious and cultural significance that need to be evaluated for their NRHP eligibility. A new archaeological survey of 5 mine areas within the proposed KMC (J-19, J-21, J-21 West, N-10, and N-11 Extension) likely will increase the number of cultural resources for the mine. Per the terms of the KMC Programmatic Agreement, each cultural resource will be evaluated for its eligibility for listing in the NRHP, and the responsible federal agency will be required to collaborate on these determinations with the Navajo Nation Heritage and Historic Preservation Department, Hopi Cultural Preservation Office, and the Zuni Tribal Historic

Preservation Office, as appropriate. These evaluations will result in a new count for historic properties in the proposed KMC study area.

Table 3.17-21 Status of Archaeological Cultural Resources by Project Feature

Project Feature	NRHP Status (number of sites)[1]							
	Listed	Determined Eligible	Recommended Eligible	Determined Not Eligible	Recommended Not Eligible	Not Evaluated	Unknown[2]	Total
NGS	—	—	—	—	—	—	4	4
BM&LP Railroad	—	—	2	—	—	—	58	60
Proposed KMC[3]	—	251	16	8	4	11	13	303
WTS[4]	1	7	34	3	39	23	22	129
STS[4]	2	3	151	1	32	65	66	320
External Communication Sites	—	—	1	—	1	1	6	9
Total	3[5]	261	204	12	76	100	169	825

[1] Data derived from the cultural resources records search report and the results of the DQAS (Graves 2015).

[2] Those archaeological cultural resources identified in the cultural resources records search but lacking information on whether or not they have been evaluated for their NRHP eligibility are assigned to Unknown status.

[3] Sites determined eligible for listing in the NRHP in the proposed KMC are under Criterion D (Graves 2015).

[4] Sites listed in and determined eligible for listing in the NRHP along the WTS and STS are under Criteria A, B, D, D, and various combinations of Criteria (Graves 2015).

[5] The Old Spanish Trail, the Grand Canyon Railway district, and the abandoned Ash Fork Hill segment of U.S. Route 66 are listed in the NRHP.

A new archaeological survey of the WTS and new TCP studies for the NGS, BM&LP Railroad, WTS, STS, and external communication sites are being conducted to improve existing cultural resources inventories and provide information in case of unanticipated discoveries during routine O&M on these facilities. It is likely that additional archaeological sites and TCPs of significance to different Tribes would be identified and would increase the number of identified properties.

3.17.4 Environmental Consequences

3.17.4.1 Issues

The 2014 public scoping process resulted in the identification of several issues related to the impacts to and treatment of cultural resources (Section 1.11). Issues of concern related to cultural resources included potential impacts to archaeological sites and human burials, and physical disturbance to TCPs (including changes in surrounding landscape appearance in relation to those locations) by NGS-KMC Project construction activities (**Table 1-12**). Most cultural resource issues identified during the scoping process and subsequent listening sessions concerned direct and indirect impacts from mining. Comments received during the 2014 scoping process generally addressed concerns resulting from the earlier BMAP work on the Black Mesa and Kayenta mines. Community listening sessions held during July and August of 2014 on Black Mesa also expressed concerns that on-going mining activities were negatively affecting human remains and burials (*Jishchaa'*) and offering places important to Navajo community members living on and near the Kayenta Mine. **Table 3.17-22** summarizes the cultural resource impact issues for the proposed KMC.

Table 3.17-22 Impact Issues Anticipated on the Proposed KMC

Impact Issue	Impact Measurement Parameter (Units)	Applicable Regulatory / Compliance Thresholds
Effects of proposed mining on archaeological sites and historical-period sites	List of NRHP eligible and listed sites defined by cultural resources record search and refined by intensive archaeological survey, inventory, and evaluation.	NHPA-Section 106, Navajo Nation Cultural Resources Protection Act, and Hopi Ordinance 26
Effects of proposed mining on historic buildings and structures	Inventory and NRHP-eligibility evaluation of standing buildings and structures to be transferred to the proposed KMC. These buildings and structures will become 50 years old beginning in 2023.	NHPA–Section 106
Effects of proposed mining on places of religious and cultural significance to Tribes (TCPs) including natural resources such as springs	Inventory of TCPs consider historic properties on the former Black Mesa and Kayenta mines; on-going ethnographic investigations for Navajo, Hopi, and Zuni tribes would result in additional TCPs that would be evaluated for NRHP eligibility.	NHPA–Section 106, American Indian Religious Freedom Act, Executive Order 13007, Navajo Nation Cultural Resources Protection Act, and Hopi Ordinance 26
Effects of proposed mining on human burials	On-going investigations related to the search for and recovery of human remains (or avoidance and protection of human remains) on the proposed KMC.	SMCRA (0 CFR Part 761.11); NAGPRA; Navajo Nation Cultural Resources Protection Act; Navajo Nation Policy for the Protection of *Jishchaa'*: Gravesites, Human Remains, and Funerary Items; and Hopi Ordinance 26

3.17.4.2 Assumptions and Impact Methodology

Potential effects on cultural resources listed in or eligible for listing in the NRHP (i.e., historic properties) are assessed using criteria defined in 36 CFR Part 800 (Protection of Historic Properties), which is the regulation that implements the NHPA of 1966, as amended. 36 CFR Part 800.5(a)(1) defines an adverse effect: "An adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the National Register in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association... Adverse effects may include reasonably foreseeable effects caused by the undertaking that may occur later in time, be farther removed in distance, or be cumulative."

Additionally, 36 CFR Part 800.5(a)(2) provides examples of adverse effects and include but are not limited to:

- Physical destruction of or damage to all or part of the property;
- Alteration of a property, including restoration, rehabilitation, repair, maintenance, stabilization, hazardous material remediation, and provision of handicapped access, that is not consistent with the Secretary's Standards for the Treatment of Historic Properties (36 CFR Part 68) and applicable guidelines;
- Removal of the property from its historic location;

- Change of the character of the property's use or of physical features within the property's setting that contribute to its historic significance;
- Introduction of visual, atmospheric, or audible elements that diminish the integrity of the property's significant historic features;
- Neglect of a property which causes its deterioration, except where such neglect and deterioration are recognized qualities of a property of religious and cultural significance to an Indian tribe or Native Hawaiian organization; and
- Transfer, lease, or sale of property out of federal ownership or control without adequate and legally enforceable restrictions or conditions to ensure long-term preservation of the property's historic significance.

The thresholds and logic for the intensity of impacts and significance are presented for cultural resources in **Table 3.17-23**. Impact intensity may range from negligible to major for cultural resources. For the purposes of this analysis, when proposed project actions have the potential to damage or destroy archaeological sites, the impact level will be considered moderate if the effect would be readily apparent, tangible, and subject to mitigation measures that considerably reduce the effect. As nonrenewable resources, individual archaeological sites cannot be replaced, but efforts can be undertaken to recover information and materials prior to removal to lessen their loss. Similarly, when proposed actions have the potential to alter, move, or demolish extant architectural features and structures that may qualify as historic properties during the proposed action time period, the impact level will be considered moderate if the effect would be readily apparent, tangible, and subject to mitigation through a variety of data recording methods.

Table 3.17-23 Definitions of Impact Magnitude Determinations for Cultural Resources

Negligible	Minor	Moderate	Major
Properties listed in or eligible for listing in the NRHP would not be directly or indirectly affected. For purposes of NHPA Section 106, the determination would be *no effect*.	Properties listed in or eligible for listing in the NRHP might be directly or indirectly affected, but the effects are unlikely to diminish the location, design, setting, materials, workmanship, feeling, or association that qualify a property for the NRHP. For purposes of NHPA Section 106, the finding of effect would be no historic properties affected or *no adverse effect*.	Properties listed in or eligible for listing in the NRHP could be directly or indirectly affected in a manner that would diminish the integrity of a property's location, design, setting, materials, workmanship, feeling, or association that qualify the property for the NRHP. Following mitigation, for the purposes of NHPA Section 106, the finding of effect would be *adverse effect*, but there is a high likelihood that the effect can be adequately mitigated by treatment developed in consultation with parties participating in the Section 106 review of the project.	Properties listed in or eligible for listing in the NRHP could be directly or indirectly affected in a manner that would diminish the integrity of a property's location, design, setting, materials, workmanship, feeling, or association that qualify the property for the NRHP. For the purposes of NRHP Section 106, the finding of effect would be *adverse effect*, and consulting parties likely would not concur that treatment could be implemented to adequately mitigate those impacts. In such a case, the Lead Agency has to consider how it would meet its Section 106 responsibilities.

For TCPs, when proposed project actions have the potential to alter, damage, or destroy biotic resources, water sources, and landforms considered TCPs by specific cultural groups, the impact level would be considered on a case-by-case basis and could range between minor and major, depending on the ability of that natural resource to recover from sustained impacts. For example, if another location for procuring specific plants, minerals, sediment, or water used in subsistence, religious, or ceremonial activities is acceptable and can be substituted for the original source, then the impact may be considered negligible or minor. If the resource can be relocated away from the impact area and culturally appropriate measures used to reinstate the resource's holiness, then the impact may be considered moderate. This situation would apply to structural features, such as trail shrines, that could regain their sacredness and utility by applying cultural appropriate rituals and ceremonies. However, if original landforms and the entire suite of biotic and abiotic resources associated with that specific place are damaged, destroyed, or encroached upon by incompatible visual, atmospheric, or audible influences caused by project actions, then the impact may be considered major because the effects could either be permanent or have long-term consequences for those who interact with this locality. Similarly, impacts would be considered major to human burials if previously unknown human remains are discovered inadvertently during mining operations.

The two programmatic agreements developed for the NGS-KMC Project define procedures for continuing inventory, evaluating NRHP eligibility, and resolving effects within the study area during project implementation. Execution of the programmatic agreement demonstrates that the responsible federal agency has met the requirements of NHPA Section 106.

3.17.4.3 Proposed Action

3.17.4.3.1 Navajo Generating Station

Under the Proposed Action, operations at NGS would continue from 2020 through decommissioning within the existing footprint and include the historical disturbance by construction of the original 3-Unit Operation power plant and associated support facilities. The ash disposal site is the only facility that could continue to expand into previously undisturbed land under the 3-Unit Operation. The estimated maximum footprint of the ash disposal site was previously investigated for cultural resources and no NRHP eligible or listed historic properties identified were within this area. Impacts to cultural resources would be none or negligible.

No TCP locations within the NGS study area have been identified; however, these facilities share the broader landscape with other human-made features and collectively may be considered to be inconsistent with the values of a TCP within sight of these features. Ethnographic studies currently underway will define the relative sensitivity of various TCPs, should they be identified. The NGS Programmatic Agreement establishes the process for evaluation and treatment of TCPs, which would be undertaken in collaboration with consulting parties, including Tribes.

3.17.4.3.2 Proposed Kayenta Mine Complex

Table 3.17-24 lists the cultural resources potentially affected by the Proposed Action under the 8.1 million tons per year (tpy) Operation. These resources include archaeological sites, architectural resources, TCPs, and currently known or suspected human burials within or adjacent to areas to be mined. This table lists historic properties and potential historic properties that may be impacted by the project. Additional historic properties, including natural and cultural resources considered to be traditional cultural resources, likely will be added to this list as a result of on-going ethnographic and archaeological inventory and evaluation. The first column on the left lists the number of properties that have been formally determined eligible for listing on the NRHP through consultation among agencies, State Historic Preservation Offices, and Tribes (e.g., Levine 1978; Martin n.d.; Graves 2015).The second column lists the number of properties recommended as eligible for listing in the NRHP by archaeologists and ethnographers who conducted cultural resource inventories at the mine through 2014 (Bungart 1997; Dongoske 2001; Sandoval 2013b; Sandoval and Begay 2006; Spurr 2014, 1998, 1997;

Spurr et al. 2004; Tsosie 2007; Graves 2015). The column entitled “not evaluated” lists cultural resources that have been identified in the cultural resources records search as having not been evaluated for their eligibility to the NRHP. The column entitled “unknown status” lists cultural resources identified in the cultural resources records search but lack associated information as to whether they have been formally evaluated for their eligibility to the NRHP. Due to the geographical extent of the mine areas and the variety of the cultural resources potentially affected (archaeological sites, architectural resources, TCPs, and human remains or burials), the impact to cultural resources would be negligible to major.

Table 3.17-24 Eligible Cultural Resources Potentially Affected by the Proposed Action 8.1 Million tpy Operation

Project Feature	Determined Eligible	Recommended Eligible	Not Evaluated	Unknown Status[1]	*Total*
Archaeological Sites[2, 3]	188	14	11	1	*214*
Architectural Resources[4]	0	0	0	0	*0*
TCPs, including Black Mesa as a geographic feature and TCL	1	13	1	0	*15*
Known or suspected human remains in archaeological sites, in family cemeteries, or as protected isolated burials[5,6]	0	13	0	0	*13*
Total	**189**	**40**	**12**	**1**	**242**

[1] Those archaeological cultural resources identified in the cultural resources records search but lacking information on whether or not they have been evaluated for their NRHP eligibility.

[2] Includes those sites identified as historic properties in **Table 3.17-9** as well as other sites with NRHP-eligibility values of “not evaluated” or “unknown”.

[3] Archaeological site data are derived from the cultural resources records search report and the results of the DQAS (Graves 2015).

[4] Extant architectural features (buildings and structures) will be evaluated for NRHP eligibility when they reach 50 years old if there is a federal undertaking.

[5] Human remains are considered sacred sites and protected under NAGPRA; they also can be considered TCPs under NHPA, Section 106 and its implementing regulation at 36 CFR Part 800. SMCRA regulation 30 CFR Part 761.11 prohibits mining within 100 feet of a human cemetery if left in place but allows mining to occur if human remains are relocated in accordance with all applicable laws and regulations.

[6] The Navajo Nation does not consider human remains, burials, or other *Jishchaa'* to be cultural resources or TCPs.

Impacts under the 5.5 million tpy Operation would be the same as the 8.1 million tpy Operation except coal resource area N-10 would not be mined, and no effects would occur to cultural resources in that area (**Table 3.17-25**).On-going archaeological inventory and ethnographic studies on behalf of the Navajo Nation, Hopi Tribe, and Pueblo of Zuni may identify additional properties beyond what are included in **Tables 3.17-24** and **3.17-25.** These properties may include Prehistoric and Historic Period archaeological sites and places of on-going religious and cultural significance to Tribes (TCPs). Following the procedures stipulated in the KMC Programmatic Agreement, these additional cultural resources would be evaluated in terms of their NRHP eligibility.

Table 3.17-25 Eligible and Potentially Eligible Cultural Resources Potentially Affected by the Proposed Action 5.5 Million tpy Operation

Project Feature	Determined Eligible	Recommended Eligible	Not Evaluated	Unknown Status[1]	*Total*
Archaeological Sites[2, 3]	175	10	9	1	*195*
Architectural Resources[4]	0	0	0	0	*0*
TCPs, including Black Mesa as a geographic feature and TCL	1	13	1	0	*15*
Known or suspected human remains in archaeological sites, in family cemeteries, or as protected isolated burials[5, 6]	0	13	0	0	*13*
Total	**176**	**36**	**10**	**1**	**223**

1 Those archaeological cultural resources identified in the cultural resources records search but lacking information on whether or not they have been evaluated for their NRHP eligibility.

2 Includes those sites identified as historic properties in **Table 3.17-9** (except those in coal resource area N-10) as well as other sites with NRHP-eligibility values of “not evaluated” or “unknown”.

3 Archaeological site data are derived from the cultural resources records search report and the results of the DQAS (Graves 2015).

4 Extant architectural features (buildings and structures) will be evaluated for NRHP eligibility when they reach 50 years old if there is a federal undertaking.

5 Human remains are considered sacred sites and protected under NAGPRA; they also can be considered TCPs under NHPA, Section 106 and its implementing regulation at 36 CFR Part 800. SMCRA regulation 30 CFR Part 761.11 prohibits mining within 100 feet of a human cemetery if left in place but allows mining to occur if human remains are relocated in accordance with all applicable laws and regulations.

6 The Navajo Nation does not consider human remains, burials, or other *Jishchaa'* to be cultural resources or TCPs.

Any impacts on historic properties that may result from the Proposed Action would be resolved through implementation of the stipulations in the KMC Programmatic Agreement. This applies to historic properties and potential historic properties documented as of 2014 (Graves 2015) as well as new historic properties documented by on-going archaeological and ethnographic investigations. These measures to resolve impacts on archaeological sites, historical-period resources, and TCPs could include avoidance, monitoring, or resolving direct and indirect impacts through the development of a Historic Properties Treatment Plan. The Historic Properties Treatment Plan would be developed in consultation with the Tribes, BIA, State Historic Preservation Office, and the parties to the programmatic agreement. Treatment of historic properties would be completed prior to the commencement of any applicable mine-related activity. Thereafter, a treatment report or reports documenting the results of treatment carried out in accordance with the Historic Properties Treatment Plan would be prepared, submitted to applicable agencies, reviewed by agencies and Tribes, finalized, and made available to applicable agencies and institutions.

If architectural remains, including the coal conveyor belt and/or one or more buildings and structures considered part of the proposed KMC facilities, are determined to be eligible NRHP, either individually or as a historic district, then Historic American Building Survey/Historic American Engineering Record or equivalent documentation would be undertaken when continued use of these historic properties may result in effects. As with development of the Historic Properties Treatment Plan, a Historic American Building Survey/Historic American Engineering Record, or equivalent, would be prepared, submitted to applicable agencies, reviewed by agencies and Tribes, finalized, and made available to applicable agencies and institutions.

The KMC Programmatic Agreement also addresses unanticipated discoveries of cultural resources and encountering unmarked burials and undocumented human remains during mine-related activities. If human remains are encountered during project-related activities, all ground-disturbing activity would cease, the discovery location would be secured, specific protocols for notifying Tribes and agencies would be followed, and appropriate treatments would be undertaken. The KMC Programmatic Agreement specifies the treatment process for these discovery situations as they apply to Navajo Nation and Hopi Tribe surface lands.

3.17.4.3.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

Operation and maintenance activities such as structure and conductor repairs (Chapter 2.0 and **Appendix 1B**) would be conducted by system operators, and the ROW access would be provided by existing service roads that are located within or adjacent to the transmission line corridor and connect to other public roads. The NGS O&M Plan (**Appendix 1B**) outlines the road system used for maintenance, and the procedures to be followed in the event that new surface disturbance would be required. In general, cultural resource surveys would be conducted in any area proposed for new ground disturbance. Coordination with the federal land management agency or land owner would occur before new ground disturbance could begin. These procedures also are contained in the NGS Programmatic Agreement, including those for unanticipated discoveries and notifications.

The existing communication sites would be operated from 2020 to 2044. These sites are fully operational and no additional modifications for the purposes of the Proposed Action would be required. As a consequence, no NRHP eligible or listed historic properties would be affected. Some communication sites are located on high terrain such as mountain tops that have been designated as TCPs. The communication sites represent long-term human-made features at these locations and, as explained in Chapter 2.0, are part of the transmission systems and would remain operational beyond 2020 with or without the proposed project. Cultural resource surveys would be conducted in any area proposed for new ground disturbance. Coordination with the federal land management agency or land owner would occur before new ground disturbance could begin. These procedures also are contained in the NGS Programmatic Agreement, including those for unanticipated discoveries and notifications.

Impacts to cultural resources from ongoing operation of the transmission systems and communication sites would be negligible.

3.17.4.3.4 Project Impact Summary – All Project Components

The study area for evaluating potential environmental impacts to historic properties corresponds to the project limits, as defined by lease and permit boundaries and ROWs, for all elements of the NGS-KMC Project. This includes the NGS and associated facilities, the proposed KMC, and the transmission systems and communication sites. The study area is depicted **Figure 3.17-1** and is described in Section 3.17.2.

The only project component with identified historic properties and potential historic properties that may be impacted by the Proposed Action are located in the proposed KMC (**Table 3.17-26**). The number of resources potentially affected consists of 195 archaeological sites for the 5.5 million tpy Operation and 214 sites for the 8.1 million tpy Operation; 15 TCPs; and 13 human remains (**Tables 3.17-24** and **3.17-25**). These resource frequencies likely will change depending on the results of the on-going archaeological surveys and TCPs ethnographic studies. Should TCPs of religious and cultural significance to the Tribes be identified within or adjacent to project components or unanticipated archaeological discoveries or discoveries of human remains occur within or adjacent to any project component, then the characterization of impacts in **Table 3.17-26** may change. The NGS Programmatic Agreement addresses these potential situations and outlines the process for addressing newly identified TCPs and unanticipated discovery situations.

Table 3.17-26 Proposed Action Impact Summary to Historic Properties and TCPs

Project Component	Archaeological Sites	Architectural Resources	TCPs	Human Burials
NGS	None	None	None[1]	None[2]
Proposed KMC	Moderate	Moderate	Negligible to Major	Moderate to Major
Transmission Lines and Communication Sites	Negligible	Negligible	Negligible [1]	Negligible [2]

[1] Thus far, none have been identified; however, on-going studies may reveal unidentified TCPs which would trigger Section 106 consideration on a case by case basis.

[2] Unanticipated discoveries would trigger Section 106 consideration on a case by case basis.

3.17.4.3.5 Cumulative Impacts

As with the Proposed Action study area, the study area for evaluating cumulative impacts to historic properties corresponds to the project limits, as defined by lease and permit boundaries and ROWs, for all elements of the NGS-KMC Project. This includes the NGS and associated facilities, the proposed KMC, and the transmission systems and communication sites. The study area is depicted **Figure 3.17-1** and is described in Section 3.17.2.

For the purposes of this analysis, past impacts to cultural resources in the proposed KMC are quantifiable because the number of archaeological sites recorded and the number of sites removed by mining over the life of mining activities are known. For the NGS, transmission systems and communication sites, past impacts to cultural resources cannot be known with the same level of specificity. For those project components, past impacts to cultural resources are estimated by the number of cultural resources recorded by survey projects and subsequently excavated prior to the construction of those project components.

Table 3.17-27 summarizes the impacts to cultural resources resulting from past and present actions, the Proposed Action, and reasonably foreseeable actions. Aside from the construction and use of the NGS and mining operations at the proposed KMC, no other industrial projects or agency actions require consideration as past or present actions because none overlap with the project area. Cumulative impacts to cultural resources are not expected to occur for the vast majority of the project. No ground-disturbing actions from other foreseeable activities overlap with the NGS and associated facilities, the proposed KMC, or the STS and the external communication sites. Ongoing ethnographic studies may identify TCPs for which cumulative impacts need to be considered. TCPs identified in the future would be managed according to guidelines contained in the NGS and KMC programmatic agreements.

Table 3.17-27 Cumulative Impacts to Cultural Resources

Project Component	Past / Present (through 2019)	Proposed Action (2020-2044)	Reasonably Foreseeable Actions
NGS	171 archaeological sites were identified in the survey conducted before the construction of the NGS and the BM&LP Railroad (Stebbins 1982; Stebbins et al. 1986; Swarthout et al. 1986). Of these 171 sites, 62 of these sites were excavated by that project (Section 3.17.3.2).	None. NGS Programmatic Agreement provides guidance for evaluation of effects to TCPs and unanticipated discoveries of historic properties within project area.	None
Proposed KMC	2,380 archaeological sites were identified in the former Black Mesa Mine and Kayenta Mine permit areas. Of these, 905 were removed by mining activity in the former Black Mesa and Kayenta Mines from 1967 to 2014 (**Table 3.17-8**). An additional 44 sites will be removed by mining preparations by 2019 in J-19, J-21, and N-9 (**Table 3.17-10**).	The Proposed Action may potentially affect 195 to 214 archaeological sites (5.5 million tpy and. 8.1 million tpy operations, respectively), 15 TCPs, and 13 human remains (**Tables 3.17-24** and **3.17-25**).	None
Transmission Lines and Communication Sites	154 archaeological sites were identified in the surveys conducted before the construction of the WTS (Brooks et al. 1975; Moffitt et al. 1978). Of these 154 sites, 47 were excavated by those projects (Section 3.17.3.4). 88 archaeological sites were identified in the survey conducted before the construction of the STS (Fiero et al. 1980). Of these 88 sites, 20 of these sites were excavated by this project (Section 3.17.3.4). Construction of external communication sites was not preceded by survey and excavation (Section 3.17.3.4).	None. NGS Programmatic Agreement provides guidance for the identification, evaluation, and treatment of effects to historic properties, TCPs, and human burials as well as unanticipated discoveries of historic properties.	TransWest Express, Southern Nevada Intertie, and Eastern Nevada transmission lines may overlap with select access roads to the WTS. Segments of the Lake Powell water pipeline and transmission line may overlap with the WTS corridor. None for the STS. None for the Communication Sites.

The only portion of the overall project for which cumulative impacts to cultural resources may occur is the WTS. The TransWest Express, Southern Nevada Intertie, and Eastern Nevada transmission lines may be constructed in an existing West-Wide ROW adjacent to the WTS from the vicinity of Mesquite to the Eldorado Valley south of Las Vegas, Nevada (**Figure 3.0-4**). Segments of the Lake Powell water pipeline and transmission line are proposed to overlap with the WTS utility corridor in Coconino County, Arizona, west of Lake Powell (**Figure 3.0-3**).

The primary potential cumulative impacts to cultural resources would be due to disturbance of previously undiscovered archaeological and burial sites with the overlapping use of existing access roads by construction and maintenance equipment for adjacent utility projects sharing the same broadly defined utility corridor. For example, the TransWest Express Plan of Development indicates it would use existing utility corridor roads with short spur roads for transmission line structure construction and operation. Any specific proposals to construct new projects and maintain existing facilities would be coordinated through the responsible BLM or other federal and tribal land management agency offices in Nevada, Utah, and Arizona. Requirement for new roads, maintenance of existing roads, and repair of damaged roads would be developed on a project-specific basis. The net result would be reduced requirements for new access roads, which would reduce the risk of discovery and damage to cultural resources from the road system.

For the WTS, the impact to cultural resources would be negligible to major due to the geographical extent of the study area for cumulative impacts, potential for ground disturbing activities from other projects, and the type of the cultural resources potentially affected. For the remainder of the cumulative study area, the impacts would be none to major, the latter due to the contributions of mine-related disturbance.

3.17.4.4 Natural Gas Partial Federal Replacement Alternative

Under the Natural Gas Partial Federal Replacement (PFR) Alternative, a selected quantity of power between 100 megawatts (MW) and 250 MW would be contracted for under a long-term power purchase agreement from currently unidentified, existing natural gas generation sources, displacing an equivalent amount of power from the federal share of NGS generation. Because the facility is assumed to currently exist, prior disturbance impacts to cultural resources have not been evaluated for that facility.

3.17.4.4.1 Navajo Generating Station

Under the Natural Gas PFR Alternative, impacts to cultural resources at the NGS would not differ from the Proposed Action 3-Unit Operation or 2-Unit Operation. No impacts to historic properties are anticipated (**Table 3.17-26**) because the area has been previously inventoried for cultural resources and minimal additional surface disturbance would be expected.

3.17.4.4.2 Proposed Kayenta Mine Complex

Under the Natural Gas PFR Alternative, impacts to cultural resources at the proposed KMC would not differ from mining 8.1 million tpy to 5.5 million tpy due to the small differences in surface disturbances compared to the Proposed Action. As for the Proposed Action, due to the geographical extent of the mine areas and the type of the cultural resources potentially affected, the impact to cultural resources may be negligible to major (**Table 3.17-26**).

3.17.4.4.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

There would be no impacts to historic properties from the existing transmission systems and communication sites (**Table 3.17-26**) because no changes in the operations of the WTS, STS, or communications sites would occur due to the implementation of the Natural Gas PFR Alternative.

3.17.4.4.4 Project Impact Summary – All Project Components

Impacts to cultural resources would be the same under the Natural Gas PFR Alternative as they would be under the Proposed Action 3-Unit Operation or 2-Unit Operation (**Table 3.17-26**). The only project component with identified historic properties and identified potential historic properties that may be impacted by the Natural Gas PFR Alternative are located in the proposed KMC. The number of resources potentially affected consists of 195 to 214 archaeological sites; 15 TCPs, and 13 human remains (**Tables 3.17-24** and **3.17-25**). These frequencies of resources will likely change depending on the results of the on-going archaeological surveys and TCPs ethnographic studies. Impacts to cultural resources would range from none to major, depending on the facility type and potential for surface disturbance.

3.17.4.4.5 Cumulative Impacts

Cumulative impacts to cultural resources would be the same under the Natural Gas PFR Alternative as for the Proposed Action 3-Unit Operation or 2-Unit Operation (**Table 3.17-27**) and would occur only for the WTS. The TransWest Express, Southern Nevada Intertie, and Eastern Nevada transmission lines may be constructed in an existing West-Wide ROW adjacent to the WTS from the vicinity of Mesquite to the Eldorado Valley south of Las Vegas, Nevada (**Figure 3.0-4**). Segments of the Lake Powell water pipeline and transmission line are proposed to overlap with the WTS utility corridor in Coconino County, Arizona, west of Lake Powell (**Figure 3.0-3**). The primary potential cumulative impacts to cultural resources would be disturbance of undiscovered archaeological and burial sites with the overlapping use of existing access roads by construction and maintenance equipment for adjacent utility projects sharing the same broadly defined utility corridor. Any specific proposals to construct new projects and maintain existing facilities would be coordinated through the responsible BLM or other federal and tribal land management agency offices in Nevada, Utah, and Arizona. For the WTS, the impact to cultural resources would be negligible to major due to the geographical extent of the study area for cumulative impacts, potential for ground disturbing activities from other projects, and the type of the cultural resources potentially affected. For the remainder of the cumulative study area, the impacts would be none to major, the latter due to the contributions of mine-related disturbance.

3.17.4.5 Renewable Partial Federal Replacement Alternative

Under the Renewable PFR Alternative, a selected quantity of power between 100 MW and 250 MW would be contracted for under a long-term power purchase agreement from a currently unidentified, existing renewable energy power source, displacing an equivalent amount of power from the federal share of NGS generation.

3.17.4.5.1 Navajo Generating Station

Under the Renewable PFR Alternative, impacts to cultural resources at the NGS would not differ from the Proposed Action 3-Unit Operation or 2-Unit Operation. No impacts to historic properties are anticipated (**Table 3.17-26**) because the area has been previously inventoried for cultural resources and minimal additional surface disturbance would be expected

3.17.4.5.2 Proposed Kayenta Mine Complex

Under the Renewable PFR Alternative, impacts to cultural resources at the proposed KMC would not differ from mining 8.1 million tpy to 5.5 million tpy due to the small differences in surface disturbances compared to the Proposed Action. As for the Proposed Action, due to the geographical extent of the mine areas and the type of the cultural resources potentially affected, the impact to cultural resources may be negligible to major (**Table 3.17-26**).

3.17.4.5.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

There would be no impacts to historic properties from the existing transmission systems and communication sites (**Table 3.17-26**) because no changes in the operations of the WTS, STS, or communications sites would occur due to the implementation of the Renewable PFR Alternative.

3.17.4.5.4 Project Impact Summary – All Project Components

Impacts to cultural resources would be the same under the Renewable PFR Alternative as they would be under the Proposed Action 3-Unit Operation or 2-Unit Operation (**Table 3.17-27**). The only project component with identified historic properties and identified potential historic properties that may be impacted by the Renewable PFR Alternative are located in the proposed KMC. The number of resources potentially affected consists of 195 to 214 archaeological sites, 15 TCPs, and 13 human remains (**Tables 3.17-24** and **3.17-25**). These frequencies of resources will likely change depending on the results of the on-going archaeological surveys and TCPs ethnographic studies. Impacts to cultural resources would range from none to major, depending on the facility type and potential for surface disturbance.

3.17.4.5.5 Cumulative Impacts

Cumulative impacts to cultural resources would be the same under the Renewable PFR Alternative as for the Proposed Action 3-Unit Operation or 2-Unit Operation (**Table 3.17-27**) and would occur only for the WTS. The TransWest Express, Southern Nevada Intertie, and Eastern Nevada transmission lines may be constructed in an existing West-Wide ROW adjacent to the WTS from the vicinity of Mesquite to the Eldorado Valley south of Las Vegas, Nevada (**Figure 3.0-4**). Segments of the Lake Powell water pipeline and transmission line are proposed to overlap with the WTS utility corridor in Coconino County, Arizona, west of Lake Powell (**Figure 3.0-3**). The primary potential cumulative impacts to cultural resources would be disturbance of previously undiscovered archaeological and burial sites with the overlapping use of existing access roads by construction and maintenance equipment for adjacent utility projects sharing the same broadly defined utility corridor. Any specific proposals to construct new projects and maintain existing facilities would be coordinated through the responsible BLM or other federal and tribal land management agency offices in Nevada, Utah, and Arizona. For the WTS, the impact to cultural resources would be negligible to major due to the geographical extent of the study area for cumulative impacts and the type of the cultural resources potentially affected. For the remainder of the cumulative study area, the impacts would be none to major, the latter due to the contributions of mine-related disturbance.

3.17.4.6 Tribal Partial Federal Replacement Alternative

Under the Tribal PFR Alternative, between 100 MW and 250 MW of power generation from the NGS would be replaced by power supplied by a new photovoltaic generation facility on tribal land, displacing an equivalent amount of power from the federal share of NGS generation. The construction of a new photovoltaic generation site on tribal land would result in between 1,200 and 3,000 acres of new surface disturbance. The Tribal PFR facility would be analyzed in a separate National Environmental Policy Act process once a facility location is identified. If this alternative is selected, the new 1,200-acre or 3,000-acre photovoltaic construction project would meet its NHPA Section 106 obligations through the standard 36 CFR Part 800 regulations.

3.17.4.6.1 Navajo Generating Station

Under the Tribal PFR Alternative, impacts to cultural resources at the NGS and Associated Facilities would not differ from the Proposed Action 3-Unit Operation or 2-Unit Operation. No impacts to historic properties are anticipated (**Table 3.17-26**) because the area has been previously inventoried for cultural resources and minimal additional surface disturbance would be expected.

3.17.4.6.2 Proposed Kayenta Mine Complex

Under the Tribal PFR Alternative, impacts to cultural resources at the proposed KMC would not differ from mining 8.1 million tpy to 5.5 million tpy due to the small differences in surface disturbances compared to the Proposed Action. As for the Proposed Action, due to the geographical extent of the mine areas and the type of the cultural resources potentially affected, the impact to cultural resources may be negligible to major (**Table 3.17-26**).

3.17.4.6.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

There would be no impacts to historic properties from the existing transmission systems and communication sites (**Table 3.17-26**) because no changes in the operations of the WTS, STS, or communications sites would occur. Additional transmission system components to connect a new photovoltaic generation site on tribal land to the electric grid would be addressed under a subsequent National Environmental Policy Act action.

3.17.4.6.4 Project Impact Summary – All Project Components

Impacts to cultural resources would be the same under the Tribal PFR Alternative as they would be under the Proposed Action 3-Unit Operation or 2-Unit Operation (**Table 3.17-26**). The only project component with identified historic properties and identified potential historic properties that may be impacted by the Tribal PFR Alternative are located in the proposed KMC. The number of resources potentially affected consists of 195 to 214 archaeological sites, 15 TCPs, and 13 human remains (**Tables 3.17-24** and **3.17-25**). These frequencies of resources will likely change depending on the results of the on-going archaeological surveys and TCPs ethnographic studies. The construction of a photovoltaic site and intertie ROW estimated to potentially disturb 1,200 to 3,000 acres (Section 2.3.2.3.) would necessitate the definition of a new area of potential effects that would be subject to federal historic preservation requirements as well as the requirements of applicable state and tribal laws (**Table 3.17-1**). The obligation to address these laws would be handled as a separate action overseen by the responsible federal agency to meet its NHPA Section 106 obligations through the standard 36 CFR Part 800 regulations. Impacts to cultural resources would range from none to major, depending on the facility type and potential for surface disturbance.

3.17.4.6.5 Cumulative Impacts

Cumulative impacts to cultural resources would be the same under the Tribal PFR Alternative as for the Proposed Action 3-Unit Operation or 2-Unit Operation (**Table 3.17-27**) and would occur only for the WTS. The TransWest Express, Southern Nevada Intertie, and Eastern Nevada transmission lines may be constructed in an existing West-Wide ROW adjacent to the WTS from the vicinity of Mesquite to the Eldorado Valley south of Las Vegas, Nevada (**Figure 3.0-4**). Segments of the Lake Powell water pipeline and transmission line are proposed to overlap with the WTS utility corridor in Coconino County, Arizona, west of Lake Powell (**Figure 3.0-3**). The primary potential cumulative impacts to cultural resources would be due to disturbance of previously undiscovered archaeological and burial sites with the overlapping use of existing access roads by construction and maintenance equipment for adjacent utility projects sharing the same broadly defined utility corridor. Any specific proposals to construct new projects and maintain existing facilities would be coordinated through the responsible BLM or other federal and tribal land management agency offices in Nevada, Utah, and Arizona. For the WTS, the impact to cultural resources would be negligible to major due to the geographical extent of the study area for cumulative impacts and the type of the cultural resources potentially affected. For the remainder of the cumulative study area, the impacts would be none to major, the latter due to the contributions of mine-related disturbance.

3.17.4.7 No Action

3.17.4.7.1 Navajo Generating Station

Under the No Action Alternative, power production at NGS would cease after 2019 unless the Navajo Nation continues NGS operations. As described in the NGS O&M Plan (**Appendix 1B**), the NGS and its associated facilities, including the BM&LP Railroad, would be decommissioned. As described in Section 2.3.1.1, operating and support facilities at the plant site would be dismantled and demolished to ground level over a several year period. The water supply facilities and certain buildings and equipment would remain in place, per the 1969 Lease and Lease Amendment No. 1 with the Navajo Nation (or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1) Except for hazardous materials and material salvaged, recycled, or sold for scrap, it is anticipated that demolished structural material would be placed within a landfill area on the NGS site and covered with soil.

As required by the 1969 Lease, the land would be restored as closely as possible to original condition where the surface of any leased land has been modified or improved. The areas that do not contain permanent facilities would have all nonindigenous material removed from the surface, and the area would be filled and graded in order to provide proper drainage; however, there would be no attempt to return the leased lands or the ROW to the preconstruction elevations. All restored land would be covered with local topsoil and revegetated with native plants to meet the lease requirements.

Decommissioning of the BM&LP Railroad would involve removal of overhead power lines, rails, and ties; applying soil to the roadbed; and reseeding. The railroad embankment would not be modified; but would be allowed remain in accordance with the lease provisions.

Given the absence of historic properties within the NGS study area (**Table 3.17-21**) and the duration of historic disturbance since the late 1960s, it is unlikely that archaeological resources would be encountered during demolition, dismantling, salvaging, or scraping of project buildings and structures, as well as grading, closing, and capping of landfills and treatment ponds. Nevertheless, actions related to cultural resources are addressed in the NGS Programmatic Agreement and Reclamation, in consultation with Navajo Nation Heritage and Historic Preservation Department and the BIA-Navajo Region, would ensure that all Section 106 requirements would be met for the decommissioning phase of the project. Therefore, decommissioning activities would have a negligible impact on cultural resources.

3.17.4.7.2 Proposed Kayenta Mine Complex

Under the No Action Alternative, mining operations within the Kayenta Mine lease area would cease before the end of 2019. Final site reclamation will take place 2 to 3 years after cessation of mining. Disposition of mine facilities and lands affected by mining would be expected to take approximately 10 to 15 years after mining ends to allow for the reclamation and bond release period (a minimum of 10 years after reclamation pursuant to SMCRA).

Under this alternative, anticipated impacts from project actions to extant archaeological sites and known TCPs and human remains would be negligible (**Tables 3.17-8, 3.17-9,** and **3.17-11**). Disturbance to an estimated 195 to 214 archaeological sites, 15 or more TCPs, and 13 human burials associated with 7,160 acres (**Table 3.17-4**) under the Proposed Action and all PFR alternatives would be avoided, resulting in greatly reduced impacts to existing cultural resources. Actions related to cultural resources, mine site reclamation, and decommissioning of mine facilities are addressed in the KMC Programmatic Agreement. The OSMRE, in consultation with the Navajo Nation Heritage and Historic Preservation Department, Hopi Tribe's Cultural Preservation Office, BIA-Navajo Region, and BIA-Western Region, would ensure that all Section 106 requirements were met for decommissioning.

3.17.4.7.3 Transmission Systems and Communication Sites

The NGS transmission system is an established part of the western U.S. transmission grid and supports reliability and delivery of power throughout the region, well beyond the power generated by the NGS. Therefore, under the No Action Alternative it is likely that that one, several, or all of the land owners/managers of the transmission line rights-of-way and communication site leases would renew some portion of the facilities to keep the power grid performing as expected.

In the event it is determined that some or all of the transmission systems and communication site ROWs are not renewed, a lengthy study and permitting process would need to occur before any decommissioning is initiated due to the essential and integral nature of these facilities with the western electric grid. As noted in

Section 2.3.3, up to 4,826 acres within and alongside the transmission system corridors could be temporarily disturbed if the entirety of the transmission systems and communication sites were decommissioned and removed.

3.17.4.7.4 No Action Impact Summary – All Project Components

Under the No Action Alternative, project-related impacts to historic properties listed in or potentially eligible for listing in the NRHP would not occur. Potential impacts to cultural resources could occur during decommissioning of project facilities or through construction of new Central Arizona Project transmission lines. The NGS and KMC programmatic agreements address decommissioning for all project components and direct the responsible federal agencies to consult with federal, state, Tribal, municipal and private landowners to address Section 106 requirements.

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Section 3.18

Socioeconomics

Acronyms and Abbreviations

1969 Lease	Navajo Project Indenture of Lease
BART	Best Available Retrofit Technology
BEA	U.S. Bureau of Economic Analysis
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BM&LP Railroad	Black Mesa & Lake Powell Railroad
BMRB	Black Mesa Review Board
BO	Biological Opinion
CAP	Central Arizona Project
CAWCD	Central Arizona Water Conservation District
CDP	Census Designated Places
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CO_2	carbon dioxide
Co-tenants	Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
Development Fund	Lower Colorado River Basin Development Fund
EIA	U.S. Energy Information Administration
EIS	Environmental Impact Statement
ERA	Ecological Risk Assessment
ESA	Endangered Species Act of 1973
FCPP	Four Corners Power Plant
HHRA	Human Health Risk Assessment
km	kilometer
KMC	Kayenta Mine Complex
kV	kilovolt
kW	kilowatt
M&I	municipal and industrial
MW	megawatt
N-Aquifer	Navajo Aquifer
NEPA	National Environmental Policy Act of 1969, as amended
NGO	Non-governmental organization
NGS	Navajo Generating Station
NGS Participants	U.S. (Reclamation), Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
NHPA	National Historic Preservation Act
NNEPA	Navajo Nation Environmental Protection Agency
NO_2	nitrogen dioxide
NO_X	nitrogen oxide
NREL	National Renewable Energy Laboratory

NTUA	Navajo Tribal Utility Authority
O&M	operation and maintenance
OSMRE	Office of Surface Mining Reclamation and Enforcement
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 microns or less
PFR	Partial Federal Replacement
PWCC	Peabody Western Coal Company
Reclamation	U.S. Bureau of Reclamation
ROW	Right-of-way
SO_2	sulfur dioxide
SRP	Salt River Project Agricultural Improvement and Power District
STS	Southern Transmission System
TPT	transactions privilege tax
TW	Terawatt
U.S.	United States
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
WTS	Western Transmission System

Contents

3.18 Socioeconomics 3.18-1
- 3.18.1 Regulatory Framework 3.18-1
- 3.18.2 Study Area 3.18-1
- 3.18.3 Affected Environment 3.18-5
  - 3.18.3.1 Navajo Generating Station and Proposed Kayenta Mine Complex – Northeastern Arizona 3.18-5
  - 3.18.3.2 Transmission Systems and Communication Sites 3.18-43
  - 3.18.3.3 Central and Southern Arizona – Area of Indirect Socioeconomic Effect 3.18-44
- 3.18.4 Environmental Consequences 3.18-56
  - 3.18.4.1 Issues 3.18-56
  - 3.18.4.2 Assumptions and Impact Methodology 3.18-56
  - 3.18.4.3 Proposed Action 3.18-58
  - 3.18.4.4 Natural Gas Partial Federal Replacement Alternative 3.18-86
  - 3.18.4.5 Renewable Partial Federal Replacement Alternative 3.18-100
  - 3.18.4.6 Tribal Partial Federal Replacement Alternative 3.18-112
  - 3.18.4.7 No Action 3.18-127
- 3.18.5 References 3.18-135

List of Tables

Table 3.18-1 Arizona Tribes with CAP Allocations 3.18-5
Table 3.18-2 2010 Population and Approximate One-way Travel Distances to NGS and Kayenta Mine 3.18-6
Table 3.18-3 Hopi and Navajo Population....................3.18-7
Table 3.18-4 Population 2000 and 2010 ....3.18-7
Table 3.18-5 Population Changes of the Navajo Nation and Hopi Reservation, 1980 to 2010 ....3.18-8
Table 3.18-6 Population of the Primary Segment of the Socioeconomic Study Area, 2000 and 2010 ....3.18-9
Table 3.18-7 Race and Ethnicity, 2010 ....3.18-10
Table 3.18-8 Labor Force Participation, Employment, and Unemployment, 2009 to 2013 ....3.18-11
Table 3.18-9 Income Characteristics of Hopi and Navajo Households Living on the Reservations, 2010....................3.18-11
Table 3.18-10 Employment by Industry, 2013 ....3.18-13
Table 3.18-11 Personal Income in Northeastern Arizona, 2013 ....3.18-17
Table 3.18-12 Personal Income by Major Source, 2013 ....3.18-17
Table 3.18-13 Nonfarm Income from Private and Government Sources, 2013 ....3.18-17
Table 3.18-14 Managerial and Non-Managerial Positions at NGS Held by Native Americans, 2015 ....3.18-18
Table 3.18-15 Place of Residence for NGS Employees, 4th Quarter 2014....................3.18-19
Table 3.18-16 Managerial and Non-Managerial Positions at the Kayenta Mine Held by Native Americans, 2015....................3.18-21
Table 3.18-17 Place of Residence for Kayenta Mine Employees, 2014....................3.18-21
Table 3.18-18 Housing Occupancy and Vacancy, 2010 ....3.18-24
Table 3.18-19 Selected Characteristics of Occupied Housing Units, 2010 ....3.18-25
Table 3.18-20 Educational Attainment of Individuals 25 Years of Age and Older....................3.18-25
Table 3.18-21 Population Forecasts for the State of Arizona, 2010 to 2020 ....3.18-26
Table 3.18-22 Population Forecasts for Northeastern Arizona, 2010 to 2020....................3.18-26
Table 3.18-23 Population 2000 and 2010, Indian Tribes with CAP Water Allocations and Counties in Central and Southern Arizona 3.18-44
Table 3.18-24 Tribes with CAP Water Allocations 3.18-45
Table 3.18-25 Income Characteristics of CAP-related Indian Reservation Residents 3.18-46
Table 3.18-26 Selected Characteristics of Agriculture in Arizona, 2012....................3.18-47
Table 3.18-27 Selected Characteristics of Farming on CAP-affected Reservations in Central Arizona, 2012....................3.18-48
Table 3.18-28 CAWCD Water Deliveries and Net Water Delivery Charges, 2014 ....3.18-49
Table 3.18-29 CAWCD Budgeted Revenues, 2014 ....3.18-51

Table 3.18-30 CAP 2014 Rates Per Acre-Foot of Delivered Water 3.18-52
Table 3.18-31 Population Forecasts for Central and Southern Arizona, 2010 to 2020 ....3.18-55
Table 3.18-32 NGS Operational and Employment Impacts of the Proposed Action 3.18-61
Table 3.18-33 NGS Labor Income and Public Revenue Impacts of the Proposed Action 3.18-63
Table 3.18-34 NGS Demographic/Community Impacts of the Proposed Action 3.18-64
Table 3.18-35 Proposed KMC Operations and Employment Impacts of the Proposed Action 3.18-67
Table 3.18-36 Proposed KMC Labor Income and Public Revenue of the Proposed Action 3.18-68
Table 3.18-37 Proposed KMC Demographic/Community Impacts of the Proposed Action 3.18-69
Table 3.18-38 Proposed KMC Sociocultural Impacts of the Proposed Action 3.18-71
Table 3.18-39 Socioeconomic Impacts of the Proposed Action Related to Transmission Systems Communications Sites 3.18-75
Table 3.18-40 Incremental Costs of Reclamation Power from NGS Associated with Selective Catalytic Reduction Installation 3.18-76
Table 3.18-41 Allocation of Federal Power from NGS for CAP 3.18-77
Table 3.18-42 Future Energy Rates for Federal Power from NGS 3.18-77
Table 3.18-43 Annual Energy Charges to CAP for NGS Power 3.18-78
Table 3.18-44 CAP Annual Energy Charges per acre-foot 3.18-78
Table 3.18-45 Comparative Impact of Energy Charges for CAP Customers 3.18-78
Table 3.18-46 Impact Summary for the Proposed Action Operations 3.18-80
Table 3.18-47 Annual Energy Output and Coal Use for the Natural Gas PFR Alternative 3.18-87
Table 3.18-48 Socioeconomic Impacts of the Natural Gas PFR Alternative Related to NGS under the Natural Gas PFR Alternative 3.18-89
Table 3.18-49 Socioeconomic Impacts of the Natural Gas PFR Alternative Related to the Proposed KMC 3.18-91
Table 3.18-50 Annual Federal Power from NGS and Natural Gas PFR Alternative Supply for CAP 3.18-93
Table 3.18-51 Incremental Costs to Reclamation due to NGS Curtailment under the Natural Gas PFR Alternative 3.18-93
Table 3.18-52 Future Energy Charges per MW hour under the Natural Gas PFR Alternative 3.18-94
Table 3.18-53 Annual Energy Charges to CAP under the Natural Gas PFR Alternative 3.18-94
Table 3.18-54 CAP Annual Energy Charges per acre-foot under the Natural Gas PFR Alternative 3.18-96
Table 3.18-55 Comparative Impact of Energy Charges for CAP Customers, 2020 to 2025 ....3.18-96
Table 3.18-56 Socioeconomic Impact Summary for the Natural Gas PFR Alternative 3.18-98
Table 3.18-57 Annual Energy Output and Coal Use for the Renewable PFR Alternative 3.18-101
Table 3.18-58 Socioeconomic Impacts of the Renewable PFR Alternative Related to NGS 3.18-102
Table 3.18-59 Socioeconomic Impacts of the Renewable PFR Alternative Related to the Proposed KMC 3.18-104

Table 3.18-60 Annual Federal Power from NGS and Renewable PFR Alternative Supply for CAP 3.18-105
Table 3.18-61 Incremental Costs to Reclamation due to NGS Curtailment under the Renewable PFR Alternative 3.18-106
Table 3.18-62 Future Energy Charges per MW hour under the Renewable PFR Alternative 3.18-107
Table 3.18-63 Annual Energy Charges to CAP under the Renewable PFR Alternative 3.18-107
Table 3.18-64 CAP Annual Energy Charges per acre-foot under the Renewable PFR Alternative 3.18-108
Table 3.18-65 Comparative Impact of Energy Charges for CAP Customers, 2020 to 2025, Renewable PFR 3.18-109
Table 3.18-66 Socioeconomic Impact Summary for the Renewable PFR Alternative 3.18-110
Table 3.18-67 Annual Energy and Coal Use for the Tribal PFR Alternative 3.18-113
Table 3.18-68 Economic Characteristics Associated with a New Photovoltaic Solar Facility 3.18-115
Table 3.18-69 Socioeconomic Impacts of the Tribal PFR Alternative Related to NGS 3.18-116
Table 3.18-70 Socioeconomic Impacts of the Tribal PFR Alternative Related to the Proposed KMC 3.18-119
Table 3.18-71 Annual Federal Power from NGS and Tribal PFR Alternative for CAP 3.18-120
Table 3.18-72 Incremental Costs to Reclamation due to NGS Curtailment under the Tribal PFR Alternative 3.18-120
Table 3.18-73 Estimated Future Energy Charges per MW hour for the Tribal PFR Alternative 3.18-121
Table 3.18-74 Annual Energy Charges to CAP under the Tribal PFR Alternative 3.18-121
Table 3.18-75 CAP Annual Energy Charges per acre-foot under the Tribal PFR Alternative 3.18-122
Table 3.18-76 Comparative Impact of Energy Charges for CAP Customers, 2020 to 2025, Tribal PFR Alternative 3.18-123
Table 3.18-77 Summary of Socioeconomic Impacts for the Tribal PFR Alternative 3.18-124
Table 3.18-78 Operations and Employment Impacts of the No Action Related to NGS and the Kayenta Mine 3.18-128
Table 3.18-79 Demographic/Community Impacts of the No Action Related to NGS and the Kayenta Mine 3.18-130
Table 3.18-80 Selected Sociocultural Impacts of No Action Related to NGS and the Kayenta Mine 3.18-131
Table 3.18-81 Energy Costs Per MW hours – Proposed Action and No Action Alternatives 3.18-133

List of Figures

Figure 3.18-1 Socioeconomic Reference Map....3.18-3

Figure 3.18-2 Navajo Nation (Northwest Portion) and Hopi Reservation....3.18-4

Figure 3.18-3 Total Full-time and Part-time Employment....3.18-12

Figure 3.18-4 Percentage Distribution of General Fund Expenditures by the Navajo Nation, 2013....3.18-23

Figure 3.18-5 Navajo Nation Chapters and Hopi Reservation....3.18-32

Figure 3.18-6 Customers with Highest CAWCD Water Deliveries, 2014....3.18-49

Figure 3.18-7 CAWCD Operating Expenses by Major Category, 2014....3.18-50

Figure 3.18-8 Water and Energy Delivery Revenue by Major CAWCD Customer Category, 2014....3.18-52

Figure 3.18-9 CAWCD Firm and Advisory Water Delivery Rates, 2014 to 2020....3.18-55

Figure 3.18-10 Annual CAP Energy Costs under the Natural Gas PFR Alternative, 2030 to 2044....3.18-95

Figure 3.18-11 Annual CAP Energy Costs for the Renewable PFR Alternative, 2030 to 2044....3.18-108

Figure 3.18-12 Annual CAP Energy Costs under the Tribal PFR Alternative, 2030 to 2044....3.18-122

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3.18 Socioeconomics

This section describes social and economic conditions and assesses the temporary and long-term direct, indirect, and cumulative effects of the Proposed Action, Partial Federal Replacement (PFR) alternatives, and the No Action Alternative. Information is provided for population and demographics, social conditions, and economic and fiscal conditions including those associated with the Navajo Generating Station (NGS) and proposed Kayenta Mining Complex (KMC) (sometimes referred to as the "two facilities").

3.18.1 Regulatory Framework

The National Environmental Policy Act (NEPA) requires that social and economic conditions be addressed, although they are not subject to direct regulation or management by the federal government. The Council on Environmental Quality (CEQ) regulations for implementing the procedural provisions of the NEPA state:

> "Human environment" shall be interpreted comprehensively to include the national and physical environment and the relationship of people with that environment. This means that economic or social effects are not intended by themselves to require preparation of an Environmental Impact Statement (EIS). When an EIS is prepared and economic or social and natural or physical environmental effects are interrelated, the EIS shall discuss these effects on the human environment (40 Code of Federal Regulations § 1508.14).

Specific supplemental guidance or requirements for assessing socioeconomic effects of proposed actions and alternatives in the context of an EIS has not been published by U.S. Bureau of Reclamation (Reclamation), Office of Surface Mining Reclamation and Enforcement (OSMRE), Bureau of Indian Affairs (BIA), the Navajo Nation, nor the Hopi Tribe. Social and economic conditions commonly are recognized and assessed as part of a wide variety of federal, state, and local planning and management processes.

3.18.2 Study Area

The study area for the socioeconomic assessment includes the geographic region that encompasses the NGS-KMC Project facilities, nearby areas and communities in which most employees of the existing NGS and Kayenta Mine do and would be expected to reside in the future, those communities most directly affected by economic and fiscal linkages to the two facilities, and those governmental institutions likely to be affected by the Proposed Action or alternatives, including No Action. The study area also encompasses those areas in Arizona, Utah and Nevada transected by the transmission system corridors. The study area recognizes the relationship between the United States (U.S.) share of power from NGS and operation of the Central Arizona Project (CAP) would indirectly affect some social and economic conditions in central and southern Arizona that are far removed geographically and in their social and economic settings from that which characterizes the project locations and surroundings in northeastern Arizona. The result of the above is an expansive geographic area that constitutes the study area for socioeconomics. However, the anticipated effects within the overall study area requires the analysis to be more focused within the broader area.

The geographic area of principal focus for socioeconomics includes the Navajo Nation, Hopi Reservation, and northern Coconino and Navajo counties, Arizona. The primary segment for socioeconomic analysis includes the Navajo chapters surrounding NGS, the proposed KMC and the Navajo chapters and portions of the Hopi Reservation surrounding it, and nearby off-reservation communities in the two counties, particularly Page[1] (**Figure 3.18-1**). This segment of the study area encompasses the region where current direct social and economic effects associated with the NGS and proposed KMC are concentrated, and where changes associated with the Proposed Action and alternatives would be focused. Consideration of key fiscal effects associated with the two facilities focuses on the affected tribal and local governments and public service entities serving the area.

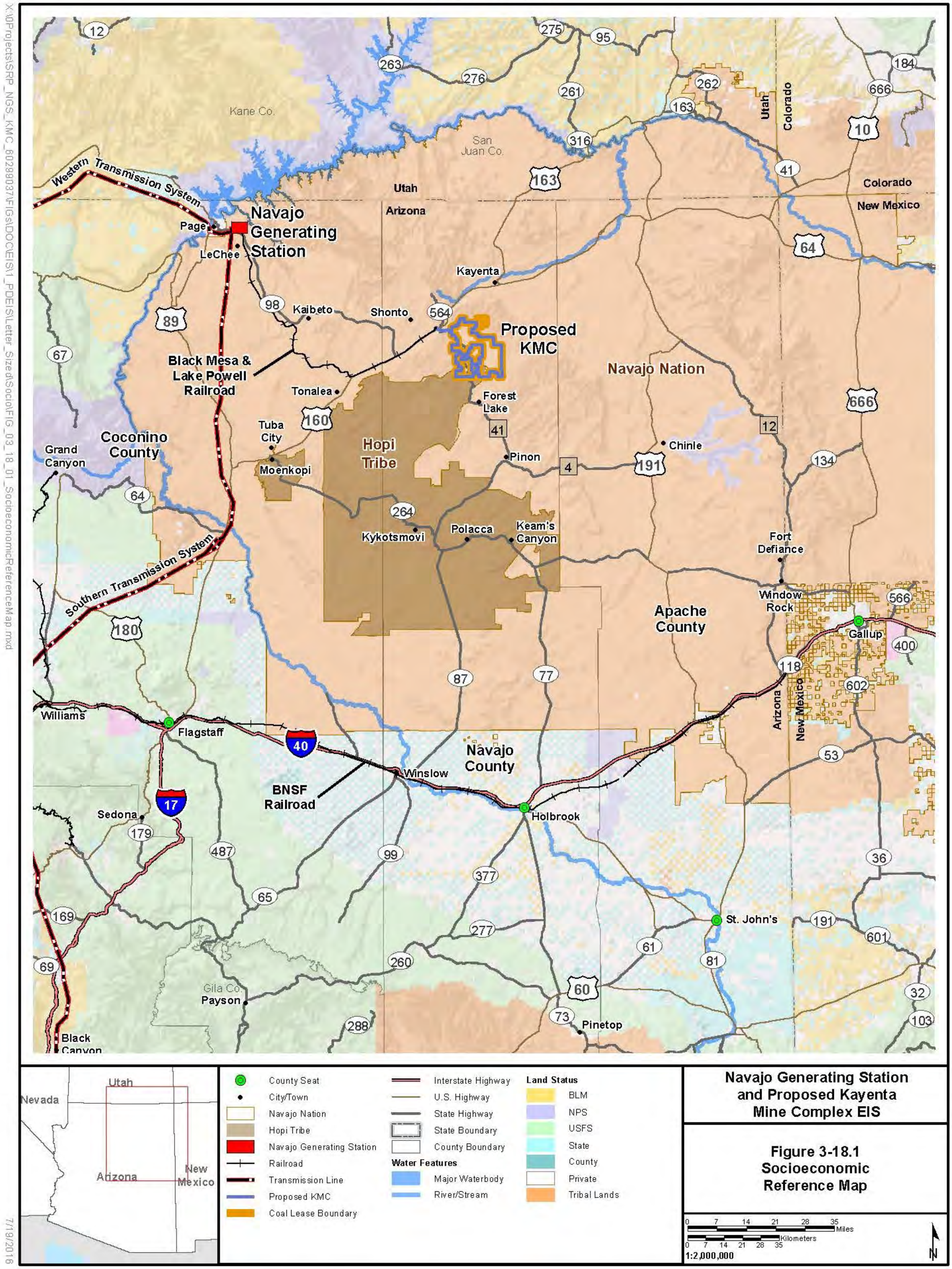
The Navajo Nation encompasses 16.22 million acres in three states – Arizona, New Mexico, and Utah. Approximately 70 percent of that total area is in Arizona. The Navajo Nation is organized into 110 chapters which represent the basis for local governance on the Navajo Nation. The Hopi Reservation, which is located entirely in Arizona, is approximately 1.56 million acres. Most Hopis live in 12 villages, located on three regions on the Hopi Reservation. **Figure 3.18-2** shows the geographical location of the major project components, adjacent and nearby Navajo Nation chapters, the Hopi Reservation and villages, and the nearby off-reservation areas.

The portion of the study area affected by the established right-of-way (ROW) corridors for the existing Western Transmission System (WTS) and Southern Transmission System (STS) systems and the communication sites includes the Navajo Nation, the Kaibab Paiute Indian Reservation (Arizona), and Moapa River Indian Reservation. It also includes Coconino, Yavapai, and Maricopa counties in Arizona; Washington and Kane counties in Utah; and Clark County, Nevada. Collectively the WTS and STS ROWs have a combined length of 532 miles. The majority of the transmission line corridors and substations are in rural areas, although segments of the WTS are located in the Las Vegas metropolitan area and segments of the STS are in the Phoenix metropolitan area.

The portion of the study area where indirect effects are likely includes 10 Indian reservations (**Table 3.18-1**) and the areas within Maricopa, Pinal and Pima counties in central and southern Arizona, encompassing the areas in which the majority of the CAP system and its associated communication and electrical distribution infrastructure are located and where CAP water deliveries are made.[2] The socioeconomic assessment for effects on the CAP system focuses on the indirect effects of changes in electrical power and pumping costs for the CAP and its users, and on the potential effects of changes in contributions to the Development Fund (see Section 1.3).

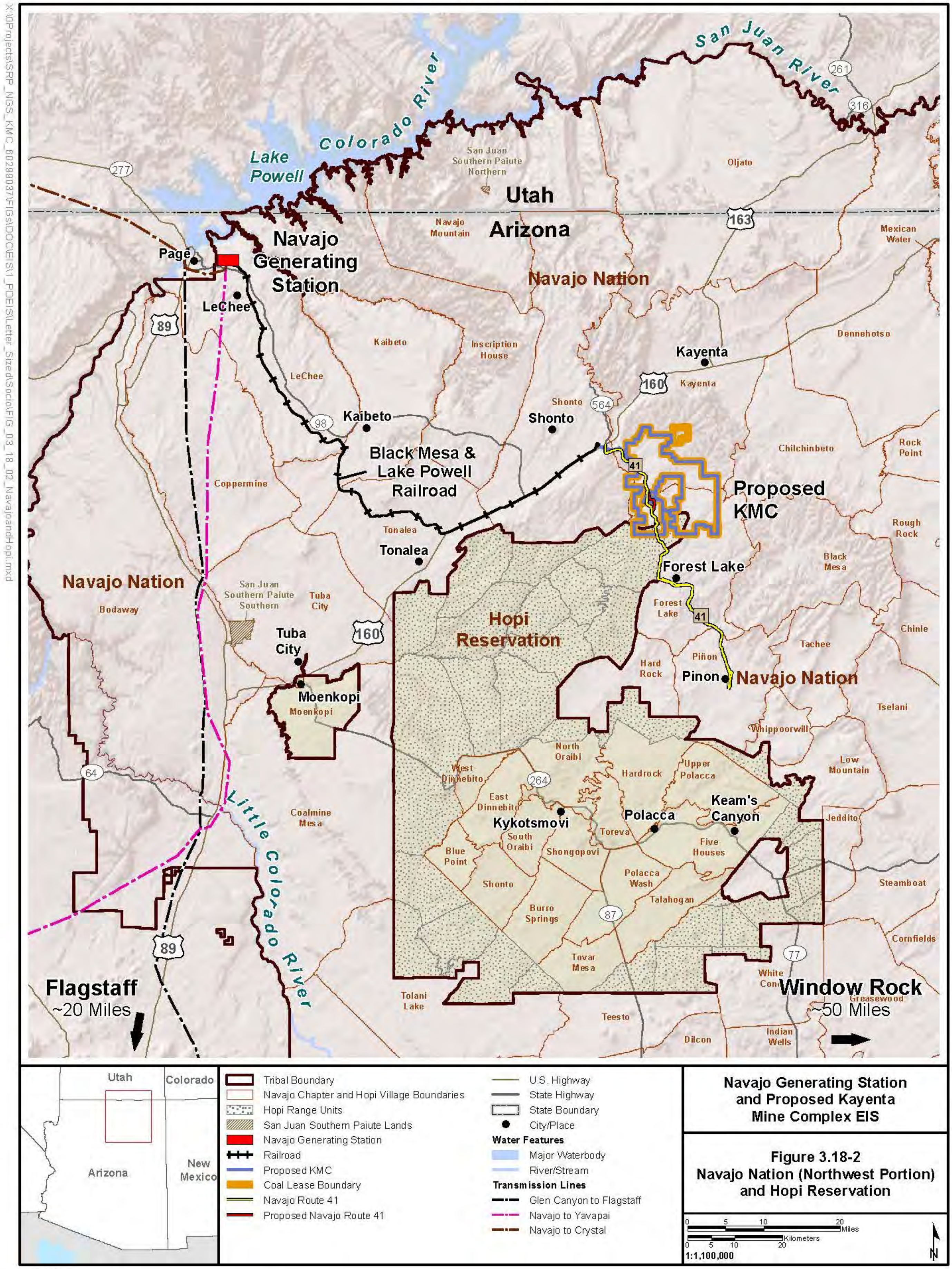
[1] Portions of The Navajo Nation, including the communities of Window Rock and Fort Defiance, are located in the northern portion of Apache County, Arizona. Some economic and demographic information for the county is included in the description of the affected environment because the Navajo Nation tribal headquarters and major administrative offices are located in Window Rock and Fort Defiance. Apache County, however, is not considered part of the primary segment of the study area because few direct socioeconomics effects would be anticipated in conjunction with Proposed Action and alternatives.

[2] The Mark Wilmer intake and pumping plant and approximately 84 miles of the CAP aqueduct system are located in La Paz County. However, no socioeconomic effects would be anticipated in La Paz County under any action alternative because no water deliveries occur in La Paz County and no physical or major operational changes in the CAP and electrical transmission facilities are contemplated under any action alternative.



Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 3-18.1 Socioeconomic Reference Map



Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 3.18-2
Navajo Nation (Northwest Portion) and Hopi Reservation

Table 3.18-1 Arizona Tribes with CAP Allocations

• Ak-Chin Indian Community	• Fort McDowell Yavapai Nation	• Gila River Indian Community	• Salt River Pima – Maricopa Indian Community
• San Carlos Apache Tribe	• Tonto Apache Tribe	• Yavapai-Apache Nation	• Pascua Yaqui Tribe
• Tohono O'odham Nation			• White Mountain Apache Tribe

Note: Portions of San Carlos Apache tribal land are located in Gila and Graham counties, Tonto Apache tribal land is located in Yavapai County, and White Mountain Apache tribal land is located in Navajo and Apache counties; however, none of the CAP system is located in those counties. The Yavapai Apache Nation and the Tonto Apache Tribe do not currently utilize their CAP allocations.

3.18.3 Affected Environment

3.18.3.1 Navajo Generating Station and Proposed Kayenta Mine Complex – Northeastern Arizona

The foundation for this section is from published secondary information from tribal, state, and federal sources; information gathered during discussions with local and Tribal officials and other stakeholders; insights gained from reviewing local print media; and reviews of numerous other studies related to social and economic conditions in the region. Generally, information for 2013 and 2014 serves as the base year for the analysis, although in some instances the data are more dated due to the data collection frequency and reporting lags inherent in the source (i.e., the detailed demographic data from the decennial Census). However, the information adequately represents the affected environment for purposes of this assessment because the underlying social and economic conditions in the area have changed little in recent years.

As described in Section 1.1, the NGS is located in northern Coconino County, on tribal trust lands leased from the Navajo Nation. The plant is approximately 5 miles east of the City of Page (2010 population 7,247), and 6 and 33 road miles, respectively, from the Navajo communities of LeChee (2010 population of 1,660) and Kaibeto (2010 population 1,522). The bulk of NGS employees – about 75 percent – live in Page, LeChee, and Kaibeto.

The NGS is the largest industrial facility operating in northeastern Arizona. The facility includes the Black Mesa & Lake Powell (BM&LP) Railroad, an electric railway operating between a coal loadout silo near the Kayenta Mine and NGS. The 78-mile-long BM&LP Railroad operates between the two facilities, in a ROW granted by the U.S. Including the railroad loops at each end, the total length of the system is 80 miles. The railroad ROW passes through rural areas of the LeChee, Tonalea, and Shonto chapters. The ROW's closest proximity to existing communities is approximately 1 mile southwest of Kaibeto and just to the south of a settlement near the intersection of State Highway Route 98 and U.S. Highway Route 160.

The proposed KMC is southwest of the Town of Kayenta, in northern Navajo County, on lands leased from the Navajo Nation and the Hopi Tribe. The administrative center of the Kayenta Mine is about 18 road miles from the Navajo Nation community of Forest Lake (2010 population 471). At approximately 40 road miles, the Navajo Nation communities of Kayenta (2010 population 6,211) and Shonto (2010 population 2,124) are more distant but require only slightly longer travel times due to access via better roads.

The settings for both NGS and the proposed KMC are rural, sparsely populated, and with considerable distances separating communities. NGS is located in a rural area with no immediately adjacent housing or large-scale commercial or industrial development. The nearest residence to NGS is approximately 1 mile southeast of the plant. As of January 2015, there were 114 residences, 6 proposed residences, and 37 vacated residences located within the proposed KMC leasehold boundary, some of which have been relocated by previous mining.

Table 3.18-2 presents 2010 populations and one-way highway travel distances between the two facilities and selected communities and Census Designated Places (CDPs) which correspond closely to Navajo chapters and Hopi Villages of the same name.[3] Flagstaff, the largest regional trade and service center in northeastern Arizona, is more than 130 miles distant from each facility.

Table 3.18-2 2010 Population and Approximate One-way Travel Distances to NGS and Kayenta Mine

Community	2010 Population	NGS (miles)	Kayenta Mine (miles)
Navajo Nation (Arizona portion)	101,835	NA	NA
Window Rock CDP (tribal headquarters)	2,712	227	159
Kayenta CDP	5,189	96	39
Tuba City CDP	8,611	76	61
Kaibeto CDP	1,522	33	51
Shonto CDP	591	60	41
Chinle CDP	4,518	162	94
LeChee CDP	1,443	6	86
Forest Lake (Chapter)	471	75	18
Hopi Reservation	7,185	NA	NA
Kykotsmovi Village CDP (tribal headquarters)	746	126	60 (unpaved)
Moenkopi CDP	964	75	60
Second Mesa CDP	962	136	58 (unpaved)
Coconino County	134,421	NA	NA
City of Flagstaff (county seat)	65,870	131	136
City of Page	7,247	5	85
Navajo County	107,449	NA	NA
City of Holbrook (county seat)	5,053	208	197

CDP = census designated place.

NA = not applicable.

Source: Google.com 2015; U.S. Census Bureau 2010a

3.18.3.1.1 Population and Demographics

As reported by the 2010 census, the population on the Navajo Nation was 173,667; a decline of 6,795 residents (-3.8 percent) as compared to 180,462 reported in 2000. A subsequent estimate

[3] CDPs are closely settled, named, unincorporated communities containing a mixture of residential, commercial, and retail areas similar to those found in incorporated places of similar sizes. Each CDP contains a core area that is associated strongly with the CDP name and houses the majority of the CDP's population, housing, commercial structures, and economic activity.

prepared for the Navajo Office of Economic Development was 212,216 (Navajo Housing Authority 2011). The Hopi Tribe had an on-reservation population of 7,185, a gain of 239 residents (0.3 percent) between 2000 and 2010. The numbers of persons self-identifying themselves as affiliated with the two tribes are substantially higher. The 2010 Census reported 332,139 persons identifying themselves as Navajo by tribal affiliation. Tribal enrollment was reported at 300,048 in 2011. The on-reservation population was equivalent to 58 percent of the total tribal enrollment in 2010 (see **Table 3.18-3**). Another 30,211 Navajo were living in 12 cities or towns on the borders of the Navajo Nation, including 2,356 living in Page and more than 17,000 in either Farmington or Gallup, New Mexico.[4] For the Hopi Tribe, 18,327 individuals indicated an affiliation with the tribe. Total enrollment of the Hopi Tribe was 14,138 as of March 2015, with the on-reservation population equivalent to 51 percent of that total.

Table 3.18-3 Hopi and Navajo Population

Parameter	Hopi	Navajo
Total population reporting tribal grouping, alone or in combination with other tribal groupings or races - 2010	18,327	332,129
Tribal enrollment (date reported)	14,138 (3/2015)	300,048 (2011)
Population on Reservation - 2010	7,185	173,667
On Reservation population as a percent of enrollment	51%	58%

Note: Not all on reservation residents are enrolled members – these statistics are intended to be an indicator only.

Sources: Hopi Tuteveni 2015; Navajo Nation 2014a; U.S. Census Bureau 2012a (January), 2010.

Other communities in the western U.S. are common destinations for Navajo and Hopi living off their respective reservations; in 2010 nearly 47,000 Navajo lived in Phoenix and Albuquerque alone. Pursuit of education, employment, and lack of available on-reservation housing are among the factors cited for emigration (Navajo Housing Authority 2011). Navajo and Hopi family ties, culture and traditions draw many of those living off-reservation back for religious, ceremonial, and clan gatherings, and many of those living off-reservation provide economic support for their extended families living on their respective reservations. That support is vital to maintenance of Navajo and Hopi culture and social stability (Hardeen 2015; Salt River Project Agricultural Improvement and Power District [SRP] 2016).

In Arizona, portions of the Navajo Nation are located in Apache, Coconino and Navajo counties. The Hopi Reservation comprises part of the latter two counties as well. The three counties had a combined population of 313,388 in 2010, a net gain of 30,175, as compared to 2000 (**Table 3.18-4**). The overall growth rate of the three counties between 2000 and 2010 percent, was substantially lower than that of Arizona as a whole.

Table 3.18-4 Population 2000 and 2010

Community	2000	2010	Change	Percent Change
Navajo Nation [1]	180,462	173,667	-6,795	-3.8
Hopi Reservation	6,946	7,185	239	0.3
Two-reservation Total	187,408	180,852	-6,556	-3.8

[4] Flagstaff, Page, Winslow, and Holbrook in Arizona, Farmington, Gallup, Bloomfield, Grants and Aztec in New Mexico, Cortez and Durango in Colorado, and Blanding, Utah.

Table 3.18-4 Population 2000 and 2010

Community	2000	2010	Change	Percent Change
Coconino County [2]	116,320	134,421	18,101	15.6
Navajo County [2]	97,470	107,449	9,979	10.2
Apache County [2]	69,423	71,518	2,095	3.0
Three-county Total	283,213	313,388	30,175	10.7
Arizona	5,130,632	6,392,017	1,261,385	24.6

[1] These counts include the population of the portions of the Navajo Nation in Utah and New Mexico.

[2] These counts include the population residing on the relevant portions of both reservations.

Source: U.S. Census Bureau 2010b, 2000.

Recent trends in Navajo Nation and Hopi Reservation populations are found in **Table 3.18-5**. In 2010, 59 percent of the on-reservation Navajo population lived in the western Arizona portion of the reservation. Census data for 1980 to 2010 indicate that population on the New Mexico portion of the Navajo Nation increased more rapidly than did the population on the Arizona portion.

Table 3.18-5 Population Changes of the Navajo Nation and Hopi Reservation, 1980 to 2010

Community	1980	1990	2000	2010	Net Change	Compounded Annual Rate of Change
Navajo Nation						
Arizona	71,241	87,578	104,565	101,835	30,594	0.9%
New Mexico	28,722	50,657	69,524	65,764	37,042	2.1%
Utah	4,554	5,272	6,373	6,068	1,514	0.7%
Navajo Nation Total	104,517	143,507	180,462	173,667	69,150	1.3%
Hopi Reservation	6,906	7,215	6,946	7,185	239	0.1%

Source: U.S. Census Bureau 2014a, 2010b, 2000, 1992, 1986.

The Census Bureau reported population declines on the Hopi Reservation between 1990 and 2010, and on the Navajo Nation between 2000 and 2010. Factors cited as contributing to the declines include out-migration by younger members of the two tribes to pursue economic opportunities and out-migration following the closure of the former Black Mesa Mine and Black Mesa coal slurry operation in 2005 (Navajo Housing Authority 2011).

The vast majority of employees at NGS report residency in Page, and the LeChee and Kaibeto Chapters of the Navajo Nation (SRP 2014).[5] Similar information for the Kayenta Mine indicated that 63 percent of workers lived in Kayenta, with another 20 percent living in Pinon, Kaibeto, Shonto, Tuba City, or Chinle. Approximately 20 percent of the mine's workforce resided in New Mexico and in Flagstaff, Phoenix, and elsewhere in Arizona.

[5] There is no home mail delivery on the Navajo Nation or Hopi Reservation. Many employees, therefore, use P.O. boxes for mail delivery and addressing. This practice may affect the reporting of residency. Although the extent of the variance is unknown, the reported residency is assumed to be representative of actual residency pattern.

In 2010, the population of the primary segment of the study area was 52,769, a net decline of 8,183 as compared to 2000. The Tuba City, Inscription House and Black Mesa chapters, and City of Page registered population gains between 2000 and 2010. The other Navajo chapters in the area recorded population declines during the same period, with the largest declines in Chinle, Pinon, and Shonto. The closure of the former Black Mesa Mine is thought to been a contributing factor to those declines. The Hopi Reservation as a whole gained population, but declines occurred in several of the individual Hopi districts (**Table 3.18-6**).

Table 3.18-6 Population of the Primary Segment of the Socioeconomic Study Area, 2000 and 2010

Chapter/District/Community[1]	2000	2010	Change: 2000-2010	Compounded Annual Rate of Change
Black Mesa Chapter	398	428	30	0.7%
Chilchinbeto Chapter	1,325	1,165	(160)	-1.3%
Chinle Chapter	8,756	8,005	(751)	-0.9%
Coppermine Chapter	673	590	(83)	-1.3%
Forest Lake Chapter	573	471	(102)	-1.9%
Inscription House Chapter	1,214	1,252	38	0.3%
Kaibeto Chapter	1,970	1,963	(7)	0.0%
Kayenta Chapter	6,315	6,211	(104)	-0.2%
LeChee Chapter	1,890	1,660	(230)	-1.3%
Pinon Chapter	3,066	2,751	(315)	-1.1%
Shonto Chapter	2,419	2,124	(295)	-1.3%
Tonalea Chapter	2,537	2,452	(85)	-0.3%
Tuba City Chapter	8,736	9,265	529	0.6%
Hopi Reservation	6,906	7,185	239	0.3%
City of Page	6,809	7,247	438	0.6%
Total	53,587	52,769	(818)	-0.2%

[1] Chapters listed are Navajo Nation Chapters.

Source: U.S. Census Bureau 2000b and 2010b.

Native Americans, primarily Navajo, were the single largest racial group in northeastern Arizona in 2010. Navajo accounted for over 90 percent of the population of the primary segment of the study area. However, in Page, the community nearest to NGS, the majority of residents were white, with Native Americans accounting for nearly 38 percent of the city's residents (**Table 3.18-7**).

Table 3.18-7 Race and Ethnicity, 2010

Community	Total Resident Population	American Indian Population (alone or in combination)	Race (percent of population)			Hispanic or Latino (percent)
			American Indian (alone or in combination)	White (alone)	Other Race(s)	
Hopi Reservation	7,185	6,912	96.2	2.8	1.0	1.9
Navajo Nation (Arizona only)	101,835	98,851	97.1	2.3	0.6	2.0
City of Page	7,247	2,745	37.9	57.6	4.5	7.3
State of Arizona	6,392,017	353,386	5.5	73.0	21.5	29.6
U.S.	308,745,538	5,220,579	1.7	72.4	25.9	16.3

Source: U.S. Census Bureau 2010b.

In general, the on-reservation populations of the Hopi and Navajo Nation are younger than those of the state and the U.S. Average household sizes for the Navajo and Hopi, 3.45 and 3.47, respectively, are noticeably larger than those across the state and the U.S. The shares of multigenerational/extended family households and those with persons 65 years and over also are higher on the two reservations than for the state and U.S.[6]

The primary segment of the study area is very rural. Population densities in the area are 2.8 and 6.4 persons per square mile in 2010, on the primary segment portions of the Hopi Reservation and Navajo Nation, respectively. By comparison, population density for Arizona as a whole was 56.35 persons per square mile.

3.18.3.1.2 Economic Conditions

This section summarizes labor market conditions and other economic characteristics in the primary segment of the study area. These data provide important perspectives into the current economic contributions of the NGS and Kayenta Mine in the regional economy.

3.18.3.1.2.1 Labor Force Participation, Employment Status, and Poverty

The general economic climate of the Navajo Nation and Hopi Reservation can be described as challenging. In part a response to limited economic opportunities, labor force participation on the Navajo Nation and Hopi Reservation is low in comparison to the statewide and off-reservation areas (**Table 3.18-8**).

[6] "Multigenerational" means three of more generations living together in the same household and can be indicative of strong family structure and also economic dependency.

Table 3.18-8 Labor Force Participation, Employment, and Unemployment, 2009 to 2013

Parameter	Navajo Nation (all)	Hopi Reservation	Apache County	Coconino County [1]	Navajo County [1]	State of Arizona [1]
Labor Force Participation (population 16 years and over)	44.2%	54.0%	44.5%	66.0%	50.6%	60.6%
Civilian Labor Force	55,437	3,086	23,447	70,788	40,239	3,038,226
Unemployed	11,988	522	4,853	6,348	7,828	316,360
Unemployment Rate	21.6%	16.9%	26.1%	9.0%	19.5%	10.4%

[1] These population counts include the population residing on the relevant portions of both reservations.

Source: U.S. Census Bureau 2014.

Unemployment is persistently high among those in the labor force. The 2009 – 2013 American Community Survey estimated unemployment on the Navajo Nation at 21.6 percent, 4.7 percent points higher than on the Hopi Reservation, and 11.2 percentage points higher than the statewide average. Local estimates of unemployment are much higher (e.g., above 50 percent) on the Navajo Nation (Navajo Housing Authority 2011).

High unemployment, low labor force participation, and factors such as reliance on seasonal and part-time employment are manifest in household incomes that are below the statewide and national norms in terms of income distribution, higher than average dependency on public assistance, and poverty rates more than double the statewide rate. In 2010, an estimated 35 percent of Hopi and 38 percent of Navajo residents on the reservations had incomes below the poverty level (**Table 3.18-9**).

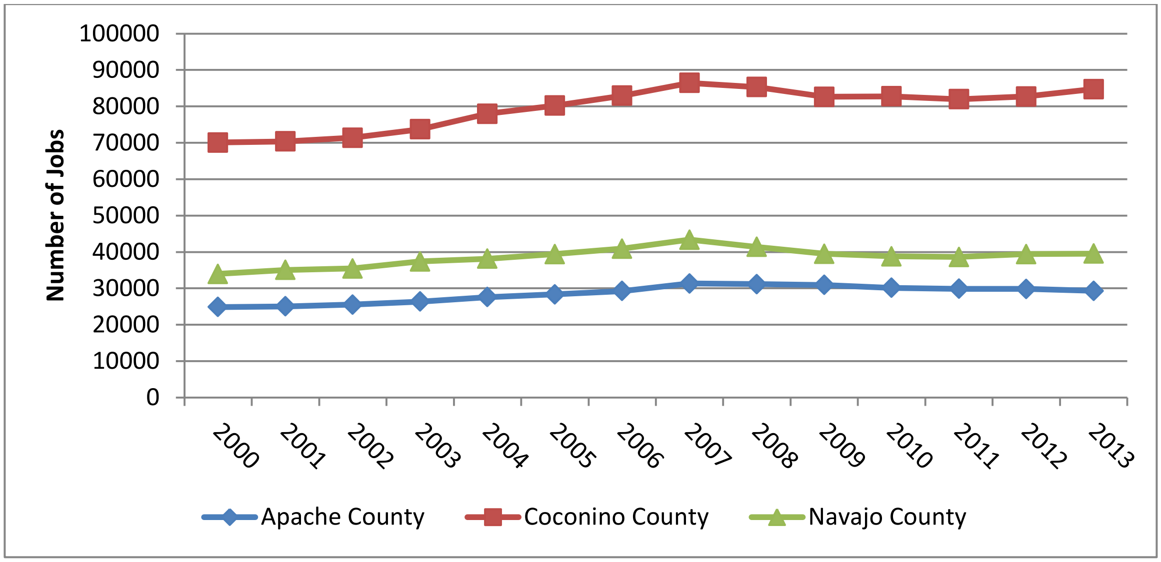
Table 3.18-9 Income Characteristics of Hopi and Navajo Households Living on the Reservations, 2010

	Household Income		Households Reporting Income from the Following Sources (percent)[1]			
Community	Less than $25,000 (percent)	Median	Earnings	Retirement Income	Public Assistance	Persons Below Poverty Level (percent)
Hopi Reservation	34.8	$34,016	79.9	19.6	29.6	35
Navajo Nation (Arizona only)	48.6	$26,401	64.0	15.7	14.7	38
State of Arizona	22.9	$50,448	78.2	18.9	9.8	15
U.S.	23.5	$51,914	79.7	17.5	10.0	14

[1] The sum of these three columns can exceed 100 percent due to households receiving more than one form of income.

Source: U.S. Census Bureau 2012b.

In 2000, total employment in the three northeastern Arizona counties was 128,882, most of which was based in Coconino County. Employment climbed steadily through 2007, with net gains ranging from 23 percent in Coconino County to 27 percent in Navajo County. In Navajo County the gains occurred as growth in the construction, real estate development, health care and other industries, exceeded the job losses following the closure of the former Mohave Generating Station, Black Mesa Mine and Black Mesa Pipeline Company. The net gain between 2000 and 2013 was 4,450 jobs in Apache County, 14,671 jobs in Coconino County and 5,555 jobs in Navajo County (**Figure 3.18-3**).



Source: U.S. Bureau of Economic Analysis (BEA) 2014a.

Figure 3.18-3 Total Full-time and Part-time Employment

Table 3.18-10 displays the top 5 industries in each geographic area, employment by major industry, by place of employment, for each of the counties in northeastern Arizona, both in absolute numbers and as the percentage of total employment. Comparable information are not published for the two reservations due to federal data reporting protocols. Four of the top five, local government, retail trade, health care and social services, and accommodation and food services, are common among the counties and the state, although the rank order differs.

3.18.3.1.2.2 Key Economic Sectors for the Navajo Nation and Hopi Tribe

Based on the published employment and earnings data, local economic development literature, perspectives gained from discussions with local officials, and other data sources, the following sectors are commonly accepted as comprising the region's economic base.

Public Sector

Broadly defined, the public sector includes tribal government, health services, education, utilities, housing authorities and other governmental and quasi-public entities. Although a comprehensive accounting of public sector employment is not available, the public sector is recognized as the single most important source of jobs, income, and services on the Navajo Nation and the Hopi Reservation.

Table 3.18-10 Employment by Industry, 2013

Parameter	Employment (Number of Jobs)			
	Apache County	Coconino County	Navajo County	State of Arizona
Total employment	29,298	84,725	39,535	3,391,722
By industry				
Farm employment	4,426	1,684	3,248	28,927
Nonfarm employment	24,872	83,041	36,287	3,362,795
Private nonfarm employment	13,892	64,493	26,320	2,921,038
Forestry, fishing, and related	249	(D)	193	15,315
Mining	229	(D)	647	23,978
Utilities	(D)	332	76	12,283
Construction	914	3,344	**1,977**	175,361
Manufacturing	612	4,907	397	168,323
Wholesale trade	(D)	1,272	504	110,891
Retail trade	**1,830**	**8,864**	**4,374**	**362,834**
Transportation and warehousing	498	2,092	1,180	97,662
Information	146	691	1,261	52,581
Finance and insurance	243	2,030	888	214,411
Real estate and rental and leasing	909	4,347	1,912	220,972
Prof., scientific, and technical services	474	3,484	933	210,736
Mgmt of companies and enterprises	-	197	283	33,623
Administrative and waste mgmt services	467	2,489	1,450	**277,117**
Educational services	636	1,048	720	71,486
Health care and social assistance	**3,143**	**9,773**	**3,801**	**367,493**
Arts, entertainment, and recreation	347	3,302	598	72,837
Accommodation and food services	**1,271**	**11,745**	**3,339**	**256,178**
Other services, exc. public administration	1,066	3,863	1,787	176,957
Government and government enterprises	10,980	18,548	9,967	441,757
Federal (civilian and military)	**2,869**	3,099	1,930	88,920
State	226	**7,559**	804	85,408
Local	**7,885**	**7,890**	**7,233**	**267,429**

Note: The top five industries in each county, in terms of the number of employees and percent of local jobs, are indicated by the shaded cells with bold entries.

(D) = Data not disclosed due to federal regulations regarding confidentiality.

Source: BEA 2014c.

Tribal Employment

The Navajo Nation and the Hopi Tribe are themselves the largest employers on their respective reservations. Tribal employment of the Navajo Nation in 2015 was 4,823 jobs, not including those jobs associated with tribal enterprises (see below) (Navajo Division of Human Resources 2015). In 2015, Hopi tribal administrative was 491 (Hopi Tribe 2016). Many of the tribal jobs are based at the respective Tribal Headquarters and administrative centers in Window Rock, Fort Defiance and Kykotsmovi.

Tribal Enterprises

Tribal enterprise operations are organizations owned and operated by the tribes whose charters are to provide services or engage in activities that are outside the umbrella of traditional tribal government. The Navajo Nation has chartered 14 enterprise activities. Current employment for these enterprises are not available, but the 2009-2010 Comprehensive Economic Development Strategy reported more than 1,500 jobs (2007 data) with just the first four enterprises above (Navajo Nation 2010). Enterprise activities for the Hopi Tribe include a ranching enterprise and a real estate enterprise.

U.S. Bureau of Indian Affairs

The BIA, the oldest bureau of the U.S. Department of the Interior, provides services (directly or through contracts, grants, or compacts) and is responsible for the administration and management of surface and subsurface minerals estates held in trust by the U.S. for the two tribes. The Navajo Region, headquartered in Gallup, New Mexico, and the Western Region, based in Phoenix, Arizona, are primarily responsible for providing services to the Navajo Nation and Hopi Tribe, respectively. The Navajo Region is comprised of five Agencies, three of which are located in Arizona; the Western Agency located in Tuba City, the Chinle Agency and the Fort Defiance Agency. The major programs/departments within the agencies are Natural Resources, Safety, Roads/Transportation, Real Estate Services, and in the case of the Fort Defiance Agency, Regional Fire Management.

BIA's Division of Real Estate Services, with regional offices in Gallup and Phoenix, has historically been responsible for ensuring that the trust and restricted federal Indian-owned lands are protected, managed, accounted for, developed, and utilized. The Navajo Nation General Leasing Regulations Act of 2013 extends Navajo leasing authority to all tribal surface lands without the approval of the U.S. Secretary of the Interior. Federal approval is still required for mineral and ROW leases (Navajo Nation 2014c). In this case, the parties have stipulated that Lease Amendment No. 1 (or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1)requires approval by the Secretary of the Interior pursuant to 25 United States Code Section 415(a).

Primary and Secondary Education

Education is a major employer in northeastern Arizona. More than 60 primary and secondary schools operate on the two reservations and in Page. The total includes schools operated by the Bureau of Indian Education, schools operating under the control of the Navajo Department of Dine Education, and public schools operated by school districts serving the northern portions of Apache, Navajo, and Coconino counties (Navajo Nation 2015a; U.S. Bureau of Indian Education 2015). A number of private and charter schools also operate in the region. The 2009-2010 Comprehensive Economic Development Strategy reported more than 2,100 jobs were associated with the Bureau of Indian Education and community schools on the Navajo Nation.

Indian Health Service

The Navajo Area Indian Health Service is responsible for health services delivery to Native Americans in portions of Arizona, New Mexico, and Utah. The Navajo Area Indian Health Service is primarily responsible for providing health care to members of the Navajo Nation. Comprehensive health care is centered on 6 hospitals and 22 health centers and health stations. Several of the hospitals on the Nation are operated by non-profit health care organizations contracted with the Indian Health Service pursuant to Public Law 93-638.

The Phoenix Area Indian Health Service Office in Phoenix, Arizona, oversees the delivery of health care to approximately 140,000 Native American users in Arizona, Nevada, and Utah outside the Navajo Nation. Indian Health Service health care facilities in the primary segment of the study area include a new facility nearing completion in Kayenta and the Hopi Health Care Center, located in Polacca. (Indian Health Service 2015a,b).

Tribal Agriculture

Raising livestock and farming are essential elements of the cultural heritage, lifestyle and economic survival of both the Navajo and Hopi peoples in northeastern Arizona. The 2012 Census of Agriculture reported 14,801 farms with 14,456 on the Navajo Nation and another 345 on the Hopi Reservation (U.S. Department of Agriculture [USDA] National Agricultural Statistics Service [NASS] 2014a,b).

Both tribes operate commercial agricultural operations as enterprise activities. The Navajo Agricultural Products Industry, with operations concentrated in the New Mexico portion of the Navajo Nation, produces potatoes, corn, alfalfa, beans, and small grains that are marketed under the brand Navajo Pride (Navajo Agricultural Products Industry 2015). Navajo Beef, another of the Nation's brands, is now served at several Navajo casinos. The Hopi 3 Canyon Ranches program includes five working ranches located south of the reservation that were purchased to regain some ancestral Hopi lands (Gashwazra 2015). The ranches are at the center of a program to provide training opportunities for Hopi youth, help sustain the important role of agriculture in Hopi culture, and to establish and market a premium brand of beef.

For many Navajo and Hopi, livestock, corn, and vegetables are essential subsistence commodities, and important for maintenance of cultural traditions, a source of cash income or a commodity for barter and exchange. In 2012, an estimated 10,735 Native American-operated farms were located in the three-county region, the overwhelming majority operated by Navajo or Hopi. Those farms reported combined sales of approximately $31.9 million, although more than 7,000 of those farms reported no sales for cash, or sales of less than $1,000. Sales of crops accounted for $19.2 million, 59 percent of the total, with the remainder derived from livestock sales. Primary crops raised in the region include corn, beans, squash, melons, and cantaloupe. Dry-land farming techniques are used on the majority of farms due to a lack of irrigation water and infrastructure. Sheep, lambs, horses and ponies were the most common types of livestock raised on the Native American farms in the three counties, with more than 7,000 farms raising sheep and lambs (USDA/NASS 2014a,b).

Mining

The Navajo and Hopi reservations sit atop abundant coal reserves. The Nation currently has limited natural gas production, however, there is potential for discovery of gas reserves depending on the economics of exploration and gas prices. Vast reserves of natural gas also are located on the Navajo Nation. Development of these resources has been vitally important to the tribes because of the jobs they provide and the revenues generated directly and indirectly to support tribal government operations. In addition to the Kayenta Mine and former Black Mesa Mine, the Nation leased areas for coal mining at the Navajo Mine in New Mexico for the Four Corners Power Plant (FCPP) near Farmington, New Mexico. Coal, electricity production, and the associated employment will decrease in response to the shutdown of three generating units at the FCPP (Fonseca 2013; OSMRE 2015).

During and after World War II, uranium mining was a major employer and source of regional economic stimulus for the Navajo Nation. The end of the cold war, along with a rising awareness of human health risks associated with uranium mining, and other factors brought a halt to such mining on the Navajo

Nation. Environmental remediation efforts are ongoing to address some of the residual issues associated with past uranium mining, processing, and waste disposal.

Utilities

Major energy related generation and transmission infrastructure is another vital element of the economic base of the regional economy. In addition to the NGS and its associated Navajo Transmission system (WTS and STS), other facilities include the Coronado and Springerville power plants in Apache County, the Cholla power plant in Navajo County, the FCPP and San Juan Generation Station in neighboring New Mexico, and multiple electrical transmission lines and natural gas pipelines across the Navajo Reservation.[7] Cholla's unit #2 will be taken off line in 2016 and two other units are scheduled to be converted to natural gas.

On the Navajo Nation, the Navajo Tribal Utility Authority (NTUA) supplies electricity, water, natural gas, wastewater treatment and solar power to residents, tribal government, and other commercial and industrial customers. NTUA's customers include the Kayenta Mine. NTUA serves nearly 40,000 customers with electricity and water, mostly in the larger communities. NTUA estimates that 15,000 families on the Nation are without access to electricity and many more are without access to running water, telephone and natural gas services. NTUA has a staff of 619 regular and temporary employees, 605 of whom are Navajo (NTUA 2015).

Tourism

Outdoor recreation and tourism are important contributors to the regional economy of northeastern Arizona, attracting millions of visitors from across the nation and abroad. Grand Canyon National Park and Lake Powell are among the primary travel and tourism attractions in the region and Interstate 40 is a major conduit for travel and tourism. Other attractions include Monument Valley, the Kayenta-Monument Valley Scenic Road, Canyon de Chelly and Wupatki National Monuments, the Hopi Cultural Center (Second Mesa) and Navajo Nation Museum (Window Rock). Hopi and Navajo artisans are world-renowned for their jewelry, weavings and other crafts.

Flagstaff offers the largest base of trade, services, and hospitality-oriented businesses in northeastern Arizona. Within the primary segment of the study area, the communities with the largest base of establishments serving the tourism and travel markets are Page, Tuba City/Moenkopi, Kayenta and Chinle; Page being the largest. Other communities in the region are much smaller, each hosting one or more motels, dining establishments, and/or convenience stores/gas stations.

The Navajo Nation voters approved gaming in 2004. The Navajo Nation Gaming Enterprise, a wholly owned business enterprise of the Navajo Nation operates four casinos, three in New Mexico and the Twin Arrows Casino east of Flagstaff (Navajo Gaming 2015). Under Arizona's Tribal/State Gaming Compact the Navajo Nation is approved to develop three more casinos.

The Hopi have twice defeated measures to approve gaming (Gashwazra 2015).

3.18.3.1.2.3 Earnings and Personal Income

In 2013, residents of the three counties comprising northeastern Arizona had combined total personal income of $9.67 billion, representing 3.9 percent of the statewide total (**Table 3.18-11**). Approximately half that total accrued to residents of Coconino County. Per capita incomes in Apache, Navajo, and the non-urban portion of Coconino counties are below the statewide average.

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[7] The Coronado, Springerville and Cholla power plants are not located on the Navajo Nation.

Table 3.18-11 Personal Income in Northeastern Arizona, 2013

Parameter	Apache County	Coconino County	Navajo County	State of Arizona
Total Personal Income – 2013 (000s)	$ 1,894,109	$ 4,906,294	$ 2,869,655	$ 245,070,457
Per Capita Income – 2013	$26,331	$35,933	$26,739	$36,983
County Per Capita Income as a Percent of Statewide Per Capita Income	71%	97%	72%	100%

Source: BEA 2014a.

In 2013, earnings accounted for less than half of the income in Apache and Navajo, compared to 62 percent statewide and 64 percent at the national level (**Table 3.18-12**). Although earnings in Coconino County are comparable to the statewide average, the overall average is not representative of income on the portion of the two reservations located in the county, but more reflective of income in Flagstaff and Sedona. Income from personal current transfers, which include unemployment, social security, and other government assistance payments, was higher, particularly in Apache and Navajo counties.

Table 3.18-12 Personal Income by Major Source, 2013

Income Source	Apache County	Coconino County	Navajo County	State of Arizona	U.S.
Earnings from employment	44%	63%	45%	62%	64%
Dividends, interest, and rent	14%	18%	16%	18%	19%
Personal current transfer receipts [1]	42%	19%	39%	20%	17%

[1] Personal current transfer receipts are benefits received by persons for which no current services are performed. Those benefits include retirement and disability insurance (mainly Social Security), medical benefits (mainly Medicare and Medicaid), income maintenance, unemployment insurance compensation, veterans' benefits, and federal education and training assistance received from government (BEA 2014b).

Source: BEA 2014b.

In addition to the fact that earnings generally account for lower shares of personal income, residents of northeastern Arizona are more heavily dependent on government income than are residents of the state as a whole. Government sources, including the Navajo and Hopi tribal governments, BIA, Bureau of Indian Education and Indian Health Service, and the state and federal governments account for 18 percent of nonfarm earnings across the state, but as much as 61 percent in Apache County (**Table 3.18-13**). The latter reflects the dominant role of the Navajo Nation government in the Apache County economy. The shares of earnings from government employers in Coconino and Navajo counties are about double the statewide average.

Table 3.18-13 Nonfarm Income from Private and Government Sources, 2013

Income Source	Apache County	Coconino County	Navajo County	State of Arizona
Private nonfarm	39%	66%	63%	82%
Government and Government enterprises	61%	34%	37%	18%

Source: BEA 2014b.

The average annual payearoll expense per employee for NGS and Peabody Western Coal Company (PWCC), approximately $145,000 and $138,000, respectively, are widely recognized as among the highest in the region. Those compensation levels, which include wages, salaries, the value of fringe benefits and other supplements, are approximately four times the corresponding averages for all employees in the three counties.

The NGS and Kayenta Mine are among the most economically significant employers in the primary segment of the study area for the Navajo Nation and for the Hopi Tribe. The economic contributions of those two establishments include the lease, royalty and other public sector revenues they pay, the jobs and payearolls they provide for tribal members and others, and the indirect and induced jobs, income and revenues supported by their operations.

3.18.3.1.2.4 Economic Contributions of the Navajo Generating Station

Total annual operation and maintenance (O&M) expense (including fuel) for the NGS ranged between $396 million and $498 million over the 4-year period 2010 through 2013, averaging $448.0 million. Major capital expenditures, which vary year-to-year, are in addition to the O&M expenditures.

Fuel expense, primarily coal, but also electricity, and motor vehicle fuel, is the single largest expense category. Annual spending for fuel averaged $287.7 million over the 4-year period 2010 to through 2013, with year-to-year fluctuation primarily reflecting differences in the quantity of coal delivered. Electrical power to operate the BM&LP Railroad is generated at NGS. Approximately 23.5 gigawatt hours (about 0.13 percent of the power generated at NGS annually) is used to operate the railroad (SRP 2014).

Labor expense is the second largest category of operating expense for NGS. NGS reported a total of 495 workers in the 4th quarter of 2014; 396 at the plant and 99 assigned to the BM&LP Railroad, 25 fewer than the approved full-staffing level of 520. The International Brotherhood of Electrical Workers represents about 400 employees at NGS. The payearoll expense for NGS in fiscal year 2014 was $71.8 million; $52.4 million in wages, salaries, sick leave, holiday and vacation compensation and $19.4 million in Federal Insurance Contributions Act, retirement, and other benefits. The total equates to an average payearoll and benefits costs of nearly $145,000 per employee (SRP 2014).

All of SRP's regular employees at NGS are full-time, either salaried or on an hourly wage basis, and are eligible for SRP's comprehensive benefits package. Among the workforce, 41 percent have 20 years or more tenure with SRP, a comparable number have between 6 and 20 years of tenure, and the remainder less than 6 years. Approximately 18 positions are filled annually in response to retirement, termination for cause, or voluntary departure by the employee (SRP 2014).

In 2015, 86 percent of the NGS workforce was Native American, including 65 percent of all managerial and supervisory staff (**Table 3.18-14**). Under terms of the existing lease with the Navajo Nation, qualified Navajo benefit from a hiring preference for available jobs. Native Americans hold managerial and non-managerial positions in all departments.

Table 3.18-14 Managerial and Non-Managerial Positions at NGS Held by Native Americans, 2015

Job Category	Share of All Such Positions Held by Native Americans (percent)
Managerial/Supervisory	65
Non-managerial	90
Total	86

Source: SRP 2015.

Adding to the economic contributions associated with NGS operation and its employees are the current retirement payments to former employees and the future payments to current employees.

SRP conducts extensive ongoing training for all employees and regularly offers specialized courses to support advancement for its employees. It also has provided introductory training for members of the community desiring to apply for employment.

Workforce residency in 2014, tabulated by mailing address zip code, indicated that 75 percent of the employees resided within a 50-mile radius of the plant, primarily in Page, Le Chee, and Kaibeto chapters.[8] Extending the radius to 75 miles captures nearly 85 percent of the total (**Table 3.18-15**). Ten percent of the workforce reported residency in Flagstaff, Phoenix, and various locations elsewhere in Arizona beyond the 75-mile radius (SRP 2014).

Table 3.18-15 Place of Residence for NGS Employees, 4th Quarter 2014

Community / Chapter	Number	Percent	Community / Chapter	Number	Percent
Page	294	59	Phoenix Metro Area	10	2
LeChee	50	10	Flagstaff and Nearby	5	1
Kaibeto	30	6	Arizona – Elsewhere	33	7
Tuba City	21	4	Utah – All	9	2
Red Lake	14	3	New Mexico – All	6	1
Kayenta	11	2	Elsewhere	1	0
Shonto	11	2	**TOTAL**	**495**	**100**

Source: SRP 2014.

Contract waste haulers and security contractors working at NGS employ another 38 on site and regular deliveries of limestone, motor vehicle fuel, and other materials and supplies employ an unknown number of long-distance truck drivers elsewhere.

In addition to fuel and labor, annual O&M at NGS averaged over $88 million over the past four years. A large portion of that total is the cost of the scheduled overhauls at the plant. Each generating unit undergoes scheduled shutdowns on 3-year cycles; once for about 4 weeks to complete a minor overhaul and then again 3 years later for about 8 weeks for a major overhaul, the net result for the 3-Unit plant being that an overhaul occurs annually. Each overhaul employs between 800 and 1,200 contractor and NGS temporary workers, generating contractor services and payearoll payments of approximately $9.5 million (minor) and $24.4 million (major) per overhaul. Outlays for equipment, machinery rentals, materials and other expenses raise the total costs to approximately $19.8 million (minor) to $46.0 million (major) (SRP 2015, 2014). These maintenance activities provide important recurrent economic infusions to the Page and Navajo Nation economies (Diak 2015; Hardeen 2015).

San Antonio, Texas-based Zachry Construction has been the prime contractor for the annual maintenance overhauls for more than 25 years, employing many local workers who return year-after-year. Like all of the labor contracts at NGS, the overhaul contracts incorporate a preference clause for hiring qualified Navajo workers. The maintenance shutdowns are scheduled for February and March to coincide with lower seasonal electrical system demand and the off-season for Page tourism, filling

[8] Residences on the Navajo Nation and Hopi Reservation do not receive mail delivery, instead using post office box addresses. As a result, not all individuals listing a particular community of residence necessarily reside in that community. However, it is reasonable to expect a high degree of correspondence between the listed zip code and approximate location of residence.

otherwise vacant lodging and generating retail, dining and fuel sales and the associated taxes. Several SRP employees indicated that the wages earned during these overhaul activities is a key source of earned income for many local contractor and temporary NGS employees, and that the income commonly provides vital support for an extended family.

The non-federal NGS Participants pay substantial taxes and in lieu of tax payments to support the Navajo Nation tribal government, local governments and other taxing districts, and public education. Property taxes on the plant and use taxes on major purchases from outside Arizona are the two major categories of taxes paid directly. As a political subdivision of Arizona, SRP is exempt from property taxes, but makes contributions in lieu of property taxes (in lieu) as outlined in Arizona Revised Statutes 48:241-248 (AZ Rev. Stat 2015). In addition, the non-federal NGS Participants make payments to the Navajo Nation equal to 50 percent of their annual tax payments to local taxing authorities. The combined in lieu, property tax and payments to the Navajo Nation total approximately $8.0 million annually, of which $2.7 million flows to the Navajo Nation, the remainder accruing to the local school district, state education equalization fund, Coconino County and local special purpose and service districts. These revenues support payrolls, service provision and infrastructure.

As a federal agency, Reclamation is exempt from paying state, local and tribal property, sales, and use taxes associated with the U.S. share in NGS.

Under the terms of the existing lease, an annual NGS lease payment of $608,400 is made to the Navajo Nation. NGS and employees at NGS provide approximately $325,000 in educational scholarships and contributions to community service groups and programs (Indenture of Lease 1969; SRP 2014).

As part of a renegotiated coal lease with the Hopi, NGS and PWCC make an annual Generation Performance Payment to the Hopi. In 2015 the payment totaled $1,365,000. Those funds were designated by the Hopi Tribal Council for deposit into the Hopi Educational Endowment fund. The fund provides financial assistance to Hopi students pursuing higher education goals (Hopi Tutuveni 2015).

3.18.3.1.2.5 Economic Contributions of the Kayenta Mine

PWCC's Kayenta Mine is the second largest industrial facility operating in northeastern Arizona. PWCC operates the mine under a "cost plus" type contract with SRP, providing a negotiated margin above the cost of production. Outlays for labor, royalties, subcontractors, utilities and local taxes totaled more $160 million in fiscal year 2014, representing a large portion of overall production costs (PWCC 2014).

In the 4th quarter of 2014, company employment at the Kayenta Mine was 440, virtually all of whom were on a full-time salaried or hourly wage status and eligible for the company's comprehensive benefits packages (PWCC 2014). Approximately 320 employees at the mine are represented by the United Mine Workers of America Local 1924. Members of the United Mine Workers of America Local 1924 ratified a 6-year contract in 2013; that contract is set to expire in September 2019.

Among the workforce, 69 percent had more than 20 years of tenure, 9 percent had 6 to 20 years tenure, and the remaining 22 percent had been at the facility 5 years or less (PWCC 2014). Over the long term PWCC fills approximately 5 positions annually in response to retirement, termination for cause, or voluntary departure by an employee. Ninety-six percent of the mine's workforce is Native American, including 77 percent of the managerial and supervisory staff (**Table 3.18-16**). Qualified Native Americans receive hiring preference for available jobs.

Table 3.18-16 Managerial and Non-Managerial Positions at the Kayenta Mine Held by Native Americans, 2015

Job Category	Share of All Such Positions Held by Native Americans (percent)
Managerial/Supervisory	77
Non-managerial	99
Total	96

Source: PWCC 2015a.

Labor is a substantial operating expense for PWCC. The company's $60.8 million payearoll expense in fiscal year 2014, included $34.6 million in wages, salaries and $26.2 million in retirement and fringe benefits such as sick leave, holiday and vacation compensation. The total equates to an average payearoll and benefits cost of nearly $138,000 per employee (PWCC 2014). Adding to the economic contributions associated with PWCC's local operations are the current retirement benefits paid to former employees and future payments to current employees. Four hundred seventy-eight (478) individuals currently receive retirement payments based on service at the Kayenta and former Black Mesa mines and administrative operations, 266 of whom were employed at the Kayenta Mine at the time of their retirement. Of the 478 total, 382 reside in Arizona, including 171 in Kayenta (PWCC 2015b).

Workforce residency at the end of 2014, based on mailing address zip code, indicated a more dispersed residency pattern at the Kayenta Mine than at NGS, with 75 percent of the workers residing within a 75-mile radius of the plant. Kayenta, Tuba City, Shonto, and Pinon are the four top places of residency (**Table 3.18-17**). Beyond that distance, 107 listed places of residence elsewhere on the two reservations or Arizona. Seven percent of the mine's workforce commute from New Mexico or Utah.

Table 3.18-17 Place of Residence for Kayenta Mine Employees, 2014

Community / Chapter	Number	Percent	Community / Chapter	Number	Percent
Kayenta	235	53	Ganado	3	1
Tuba City	25	6	Many Farms	3	1
Shonto	23	5	Dennehotso	2	0
Pinon	19	4	Kykotsmovi	2	0
Flagstaff and Nearby	17	4	Cameron	1	0
Page	12	3	Elsewhere in Arizona	47	11
Chinle	10	2	New Mexico – All	20	5
Kaibeto	10	2	Utah – All	7	2
Teec Nos Pos	4	1	**Total**	**440**	**100**

Source: PWCC 2014.

Sixteen contractors and vendors hold long-term contracts to provide maintenance, reclamation and security services at the mine, with a total of 79 employees assigned to the mine. In 2013 those contracts had a combined value of $11.6 million.

Royalties paid to the tribes by PWCC averaged $40.6 million a year over the 3-year period 2011 to 2013; The distribution of payments between the two tribes can vary year-to-year based on production, but will average 67 percent to the Navajo and 33 percent to the Hopi over the long term.

PWCC makes annual bonus payments to the two tribes. These payments are established by contract and triggered and paid by any production within one year. Annual coal bonus payments to the two tribes from 2005 to 2014 averaged $7.5 million (PWCC 2015c).

In 2014, PWCC provided $435,000 in educational scholarships and more than $900,000 in donations to community, activities and program. Employees of the mine made additional monetary contributions and also volunteered time to various causes and programs.

PWCC reported payments of $25.3 million in other taxes and fees in 2013. The total includes local property taxes paid to Navajo County and other local taxing jurisdictions and transactions privilege tax (TPT)/sales taxes.

PWCC's lease agreements with the Navajo Nation and Hopi Tribes provide for the use of groundwater. While the specific financial terms of the agreements are confidential, fees are paid monthly and are subject to escalation over time. Over the past 5 years, PWCC paid an average of $1.3 million in water fees per year, based on average annual use of 1,400 acre-feet (PWCC 2015a,j). An increase in water fees, retroactive to 2015, is pending approval by the Hopi Tribal Council and the Secretary of the Interior. The closure of the former Black Mesa Mine and Black Mesa coal slurry pipeline in 2005 resulted in substantial reductions in water use and water fee revenue.

NTUA supplies the electrical energy used at the mine. PWCC payments for electrical power have averaged $9.9 million per year over the past 3 years.

PWCC makes payments into the federal Abandoned Mine Land Reclamation and the Black Lung Disability Benefit programs. Payments into these programs are based on production at the Kayenta Mine and rates established by Congress. Coal producer payments into the Black Lung Disability Trust Fund are the lower of $0.55 per ton or 4.4 percent of the sales price. Assuming the $0.55 per ton rate applies to the Kayenta Mine, Peabody's annual payments in the fund would be $4.56 million, based on annual production of 8.1 million tons (Internal Revenue Service 2005).

The Abandoned Mine Land fund was established in the Surface Mining Control and Reclamation Act of 1977 and most of the reclamation fees collected return to states and tribes in the form of grants to fund Abandoned Mine Land reclamation projects. PWCC's annual payments into the Abandoned Mine Land are about $2.55 million based on annual production of about 8.1 million tons at the Kayenta Mine. The Navajo Nation has been awarded $30.1 million in Abandoned Mine Land grants during the 4-year period 2011 through 2014. Awards to the Hopi during that period total $4.1 million (OSMRE 2015a,b).

3.18.3.1.2.6 Overview of the Navajo Nation Budget

For fiscal year 2014, the Navajo Nation recorded total revenues of $883.25 million and total expenses of $565.43 million. Operating and capital grants and contributions, the majority of which come from the federal government and are earmarked for use in specific programs, accounted for more than $342.4 million of the revenue. Included in those totals were net general fund revenues of $231.9 million and current year expenses of $208.0 million (Navajo Nation 2014b). The difference is accounted for by transfers to other funds, changes in fund balances and year-end encumbrances. The general fund revenues are vitally important to the Navajo Nation as they are what allow the Nation to exercise its sovereignty (Navajo Nation 2015).

Tax revenues, including sales and possessory interest taxes, the latter akin to a property tax, totaled $90.7 million. Mining related revenues, including royalties and bonus payments derived from the Kayenta Mine, but also the Navajo Mine in New Mexico, totaled $63.8 million, or 27.5 percent of the total revenues. Those revenues were nearly equaled by the $58.8 million in similar revenues from oil and gas produced from the Nation's resources. Lease, rental and other revenues derived from land, buildings, and ROWs was the fourth major category of revenues, accounting for $64.3 million. ROWs for oil and gas pipelines have accounted for substantial increases in such revenues in recent years (Navajo Nation 2014b).

Expenditures for general government, including the operations of the executive, legislative and judicial functions totaled $85.1 million, which was 41 percent of the 2013 total general fund expenditures (**Figure 3.18-4**). These functions include the overall administration and management for the Nation. Community and rural development (18 percent), natural resources (13 percent), and education and training (11 percent) are the other major functions accounting for more than $20 million in total expenditures (Navajo Nation 2014b).

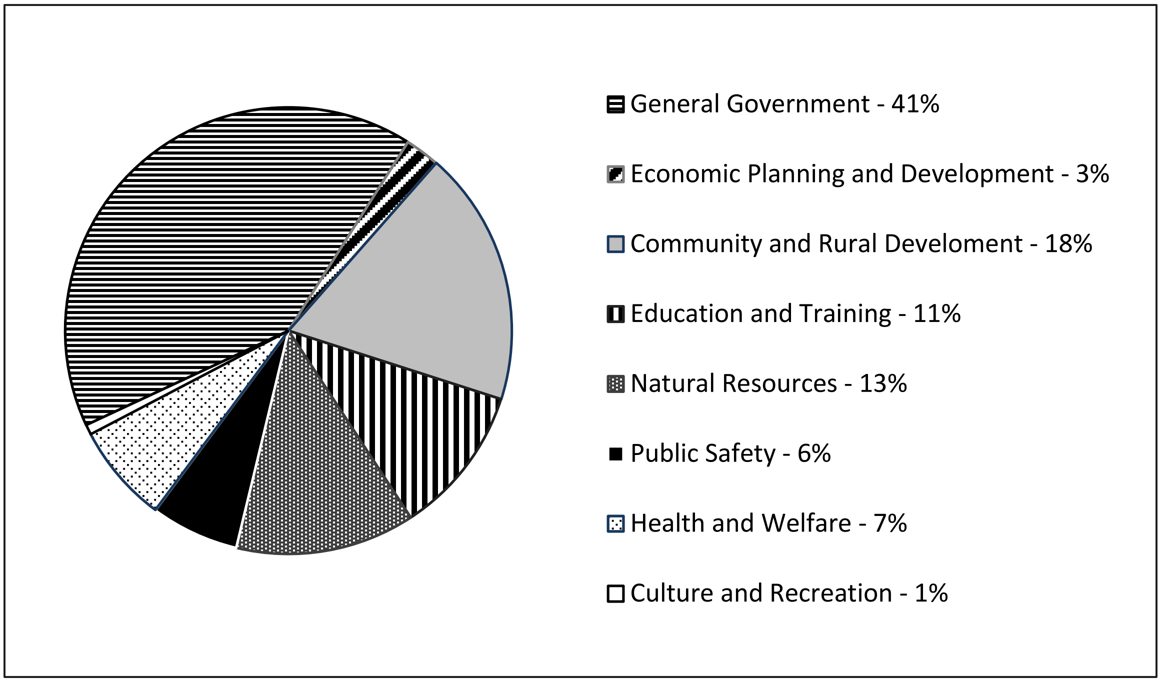

Figure 3.18-4 Percentage Distribution of General Fund Expenditures by the Navajo Nation, 2013

The expenditures shown above do not include the budgets for the Navajo Tribal Utility Authority, Navajo Agricultural Products Industry, Navajo Nation Hospitality Enterprise, Navajo Housing Authority and other enterprise activities that are legally separate from, but financially accountable to the Nation. Budget data for these enterprise activities are not publicly available.

3.18.3.1.2.7 Overview of the Hopi Tribe Budget

In 2005/2006, mining related revenues derived from the combined operations of the Kayenta and former Black Mesa mines and Black Mesa coal-slurry pipeline were reported to account for 50 to 55 percent of the Hopi general operating budget. In 2010, following reductions in budgetary adjustments associated with the closure of the Black Mesa Mine and Black Mesa coal-slurry pipeline, the Hopi reported that mining related revenues represented approximately 88 percent of the Tribe's annual budget (Hopi 2010). Although the specific percentage value may vary year-to-year, the tribe remains heavily dependent on revenues related to operation of the mine.

The Hopi Tribal Council approved a 2015 General Fund budget of $23.49 million. The general fund is the primary operating fund for the tribe, providing funding to each of the villages, the legislative, executive and judicial branches, and other operating departments and offices. Details regarding the sources of revenue are not available; however, the royalty and bonus revenue derived from operations of the Kayenta Mine are the single major source of general fund revenues. Other sources of revenues include grants, investment earnings, and revenues from business licenses, charges for services, reserves, other miscellaneous revenues, and transfers from the Tribe's enterprise activities.

3.18.3.1.3 Housing Characteristics

Housing availability, affordability, and conditions are important elements of communities and also important indicators of socioeconomic conditions. Drawing on information from the U.S. Census Bureau, Navajo Housing Authority and Navajo Land Department, the following characterize important information regarding housing on the Navajo Nation and Hopi Reservation (**Tables 3.18-18** and **3.18-19**).

- The housing stock on the Navajo Nation includes more than 8,000 public rental and homeownership units managed by the Navajo Housing Authority.
- Despite high reported vacancy rates, housing need is high on both reservations as many of the vacant homes are substandard.
- Homeownership rates in the region are equal to or higher than across the state as a whole. However, since the underlying land cannot be held as private, the equity value of homes is lower in comparison to off-reservation homes.
- Mobile homes comprise larger shares of the existing inventory of housing on the two reservations than they do across the state as a whole.
- More than 15 percent of occupied homes on both reservations do not have access to a motor vehicle and the frequency of occupied homes having an average of more than 1.5 occupants per room is substantially higher than the statewide average of 1.3 percent.
- Of the occupied homes, more than 15 percent of those on the Hopi Reservation and 20 percent of those on the Navajo Nation reported lack of complete plumbing facilities, complete kitchen facilities, and/or telephone service; these rates are as much as 25 times the statewide averages.
- More than 60 percent of the occupied housing units on the Navajo Nation and the Hopi Reservation rely on wood for heating, 30 times the statewide average statewide (those on the reservations constituting the majority of the statewide total).
- Wood and coal are used for heating in some homes on the two reservations; those using coal may obtain it for free or for a fee at the Kayenta Mine or purchase it from local vendors who buy and resell coal produced at the mine.
- Single room homes are much more common on the reservations, particularly on the Navajo Nation, than elsewhere in the state. This reflects the continued use of hogans, the traditional Navajo dwelling.

Table 3.18-18 Housing Occupancy and Vacancy, 2010

Geographic Area	Total Housing Units	Number of Occupied Units	Percent Owner Occupied Units	Number of Vacant Units	Percent Vacant	Percent Mobile Homes
Navajo Nation	68,945	43,623	63.3	25,322	36.7	19.8
Hopi Reservation	2,782	1,991	74.6	791	28.4	16.4
Arizona	2,859,768	2,370,289	64.4	489,479	17.1	10.7

Source: U.S. Census Bureau 2010b.

Table 3.18-19 Selected Characteristics of Occupied Housing Units, 2010

Geographic Area	Occupant Has No Vehicle Available	More than 1.5 Occupants per Room	One Room	Lack Complete Plumbing Facilities	Lack Complete Kitchen Facilities	No Telephone Service Available
Navajo Nation	15.2%	9.6%	22.7%	21.4%	17.1%	23.2%
Hopi Reservation	19.3%	7.5%	7.9%	17.2%	18.3%	3.7%
Arizona	6.9%	1.3%	2.2%	0.8%	0.9%	3.0%

Source: U.S. Census Bureau 2010b.

3.18.3.1.4 Educational Attainment

More than twice as many Navajo adults did not complete high school compared to the Arizona statewide average. (**Table 3.18-20**). The percentage of Navajo and Hopi adults completing high school but not continuing to college is higher than the statewide average. Consequently, the percentages of Navajo and Hopi having a bachelor's or advanced degree are substantially lower than the 26.9 percent of all Arizona residents.

Table 3.18-20 Educational Attainment of Individuals 25 Years of Age and Older

Geographic Area	Did Not Complete High School	High School or Equivalent, No College	Some College or Associate Degree	Bachelor's or Advanced Degree
Navajo Nation	30.0%	33.5%	28.8%	7.7%
Hopi Reservation	16.8%	32.2%	41.7%	9.3%
Arizona	14.3%	24.5%	34.3%	26.9%

Source: U.S. Census Bureau 2014.

Both Tribes have tribal scholarship and financial assistance programs to assist members achieve their educational goals. NGS and PWCC both make annual contributions to support those programs and both conduct extensive training programs to help employees advance their careers.

3.18.3.1.5 Factors that May Contribute to Socioeconomic Changes through 2019

The NGS currently is authorized to operate through 2019. The socioeconomic affected environment must therefore consider possible near-term changes in socioeconomic conditions. Although no well-defined, committed major projects or actions have been identified that could substantially alter northeastern Arizona socioeconomic conditions by 2019, the following trends, projects, or other economic and community development activities could affect socioeconomic conditions in some areas.

3.18.3.1.5.1 General Population Growth

Recent population projections prepared by the Arizona Department of Administration indicate moderate to strong growth (between 13 and 20 percent) could occur in the State of Arizona through 2020 (**Table 3.18-21**).

Table 3.18-21 Population Forecasts for the State of Arizona, 2010 to 2020

Projection Scenario	2010	2020	Absolute Change 2010 – 2020	Percent Change
Low Growth	6,392,017	7,225,100	833,083	13
Medium Growth	6,392,017	7,485,400	1,093,383	17
High Growth	6,392,017	7,698,200	1,306,183	20

Source: Arizona Department of Administration 2012a.

The population projections for northeastern Arizona anticipated much lower growth; the net changes range from 5 percent (16,212 residents) under the low series to 8 percent (25,112 residents), under the high series (**Table 3.18-22**). Coconino County is anticipated to realize the largest share of growth under all of the scenarios; up to 11,200 additional residents under the high series. Most of that growth would likely occur in the Flagstaff area, although some could occur in Page and the portions of the Navajo Nation and Hopi Reservation located within the Coconino County borders (Arizona Department of Administration 2012b).

Table 3.18-22 Population Forecasts for Northeastern Arizona, 2010 to 2020

		Projected Population in 2020		
	2010 Census	Low Growth	Medium Growth	High Growth
3-CountyTotal	313,388	329,600	334,600	338,500
Net Change 2010-2020	NA	16,212	21,212	25,112
Net Change (percent)	NA	5%	6%	8%

NA = not applicable.

Source: Arizona Department of Administration 2012a.

3.18.3.1.5.2 Potential Economic and Community Development Activities

The following ongoing and potential future activities are located in or could involve regional-level actions or programs affecting the Tribes and thereby affect the affected environment in the primary segment of the study area through the end of 2019.

<u>Other power plants and coal mines in the region</u>: Three existing power plants and several coal mines are located outside of primary segment of the study area, but collectively contribute to the region's economic base and to the fiscal and economic stability of the region. Several of these are or have recently undergone retrofits, closing of one or more units, conversion to natural gas, or changes of ownership. The socioeconomic implications of these changes is unclear, but generally underscore the importance of the jobs, income and tribal revenues associated with the NGS and the Kayenta Mine, particularly in the future if the contributions from these other sources decline.

- Four Corners Power Plant and Navajo Mine (New Mexico)
- San Juan Generating Station and San Juan Mine (New Mexico)
- Cholla Power Plant (Navajo County)
- Other projects: In addition to NGS, FCPP, San Juan and Cholla generating stations, the Escalante, Coronado, and Springerville generating stations and El Segundo, Navajo, and Lee's Ranch mines operate in northeastern Arizona and nearby northwestern New Mexico.

New Hopi Villages: The Hopi have announced plans to develop one or more new villages as part of the tribe's long-term community and economic development strategy. New residential and commercial development is sought to accommodate future population growth and to allow off-reservation Hopi to return. Any related activity before 2019 would most likely involve further planning and perhaps initial site preparation and utility construction. Such activities would not substantially alter socioeconomic conditions in the primary segment of the study area.

Potable water development project near the Kayenta Mine: The Many Mules Water Project is designed to deliver water to residents in the Kayenta and former Black Mesa mines lease and surrounding area (this project is discussed further under the *Sociocultural Setting* heading below). Construction of Phase I is anticipated to begin in 2016 with initial deliveries in 2018.

Development in the former Bennett Freeze Area: Originally enacted by the BIA in 1966, the "Bennett Freeze" effectively prohibited new development, including extension of utilities, road improvements, and even maintenance and repairs of existing properties across the southwestern portion of Navajo-Hopi Partitioned lands. In 2009, President Obama signed a law repealing the Bennett Freeze (Section 10(f) of Public Law 93-531), paving the way for efforts to address the many needs of the region's residents. At the time of this assessment, no comprehensive development strategy is in place, making any large-scale activities by 2019 uncertain. As a result, activities before 2019 are unlikely to substantially affect socioeconomic conditions in the primary segment of the study area.

Proceeds of the Cobell Indian Trust Settlement: In 2014, the Navajo Nation reached a $544 million settlement with the federal government, as part of a settlement of a larger class-action suit, *Cobell v. Salazar,* regarding the alleged mismanagement of funds and natural resources on the Navajo Nation. Since the settlement, the Navajo Nation has been engaged in a process to define and prioritize potential uses of the funds. In January 2016, the 23rd Navajo Nation Council approved $180 million for water and sanitation system improvements across the Navajo Nation (Navajo Nation Council 2016). Plans for the remaining funds have not been released. Activities related to the use of those funds are unlikely to substantially affect socioeconomic conditions in the primary segment of the study area prior to 2020.

General Leasing Act Implementation for the Navajo Nation: In 2014, the Interior Department approved the Navajo Nation General Leasing Regulations Act of 2013. That act extends Navajo leasing authority to all tribal surface lands without the approval of the Secretary of the Interior. Federal approval is still required for mineral and ROW leases. Although future development could occur prior to 2020, no specific changes are considered as part of the affected environment.

3.18.3.1.6 Sociocultural Conditions and Trends

This section describes recent and current relevant sociocultural conditions and trends for the area that includes NGS, the Kayenta Mine, and the former Black Mesa Mine. Concerns about historic and current operations of these facilities expressed during scoping and in contacts with local residents and tribal and community officials also are discussed. As noted above, the primary segment of the study area includes the Navajo Nation, Hopi Reservation, and northern Coconino and Navajo counties, Arizona, with a focus on the Navajo chapters surrounding NGS and the Kayenta Mine lease area, and the nearby off-reservation community of Page. The area is predominantly rural with a number of dispersed communities ranging from about 400 residents to about 9,000 residents.

NGS and the Kayenta Mine have been in operation for over 40 years; consequently the historical operations of these facilities and the related effects are considered part of the affected environment for this socioeconomic assessment. Because of this long history, the economic contributions and concerns about environmental, health, and sociocultural effects of these facilities are well known. The Navajo Nation and the Hopi Tribe, along with OSMRE, BIA, Indian Health Service, SRP, PWCC, and other agencies and institutions have ongoing initiatives and mechanisms to address many of these effects and concerns. The experience with current and historical operations of the two facilities provides useful insights into potential sociocultural effects of the Proposed Action and alternatives.

In general, sociocultural conditions are anticipated to remain relatively unchanged through 2019, with the exception that some predominately Navajo households near NGS that are presently unserved by electricity may receive service and some homes within and near the Kayenta and former Black Mesa Mine lease areas may receive residential water service as part of Phase 1 of the Many Mules Water Project (discussed further in the following section).

3.18.3.1.6.1 Sociocultural Setting

The sociocultural setting in the primary segment of the study area has been influenced by a long and complex history of interactions between the Navajo Nation and the Hopi Tribe, between each tribe and the federal government, and between each tribe, SRP and PWCC. Each tribe's traditional cultural beliefs and values,[9] and socioeconomic trends including poverty, limited employment opportunities, high unemployment, housing shortages, and lack of infrastructure are major influences on sociocultural conditions.

Sociocultural trends on the Navajo Nation and Hopi Reservation over the past century include population growth, emigration to off-reservation locations, an increasing reliance on wage and salary employment, a change to on-reservation education as opposed to off-reservation boarding schools,[10] increased use of English as both a primary and secondary language, and the establishment of Tribal governments (Hopi Office of Community Planning and Economic Development 2001; Lyon 2003). For the Navajo, sociocultural trends have been influenced by livestock reduction programs of the 1930s and 1940s.

In the part of the Navajo Nation that includes the Kayenta Mine lease area, and in the northeastern part of the Hopi Reservation, sociocultural trends have been influenced by the passage of the 1974 Navajo-Hopi Land Settlement Act as amended in 1980. Implementation of that Act resulted in the relocation of thousands of residents from the designated "partitioned lands." Although some Hopi were relocated, the majority (99 percent) of relocations were Navajo (U.S. Department of the Interior 2014).

Today, members of the Navajo Nation and Hopi Tribe may work in contemporary occupations both on and off reservation while maintaining aspects of their culture, customs and traditional lifestyles (Black Mesa United, Inc. 2005; Hopi Office of Community Planning and Economic Development 2001).

Grazing is the primary land use within the proposed KMC permit area while farming is a minor use; both are important from an economic and a cultural standpoint. Mining activity at the Kayenta Mine has resulted in displacement of some grazing within the permit area. Permittees whose grazing is displaced receive compensation from PWCC under arrangements developed in consultation with the Navajo Nation. As mining and reclamation is completed, PWCC works with the grazing permittees and chapters to reestablish grazing in the area and to implement sustainable grazing practices (see Section 3.14, Land Use). The resulting grassland communities are intended to increase the livestock carrying capacity and improve the potential for grazing management (OSMRE 2011). Forage production for livestock could increase substantially over the original forage productivity of the land (OSMRE 1990). Surveys completed during the mid-1980s identified 31 small fields on the leasehold, primarily for growing corn. The total acreage of the fields was approximately 138 acres. These plots were typically located on terraces adjacent to major drainages that are not normally disturbed by mining activities. Many were located near individual or clustered home sites. Some of these areas have been withdrawn for mining over the past 30 years.

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[9] Navajo and Hopi traditional values are discussed in a later subsection.

[10] A result of the Indian Self-Determination Act of 1972.

Poverty has been a persistent problem on both the Navajo Nation and the Hopi Reservation. As shown in **Table 3.18-9**, poverty rates for both tribes are more than double the national average. The availability of jobs on the Navajo Nation and the Hopi Reservation has not kept pace with the number of Navajo and Hopi entering the workforce, resulting in persistent high unemployment and fostering off-reservation emigration. Consequently, existing jobs, particularly well-paying jobs such as those at NGS and the Kayenta Mine, are an important source of income and economic activity in the primary segment of the study area. Even the temporary jobs associated with the annual overhauls are highly valued among the Navajo in Page and the northwestern portion of the Navajo Nation. Equally important are the tribal services and employment supported by NGS and Kayenta Mine-related taxes, royalties and other payments (Etsitty 2014; Honanie 2014). Direct, indirect, and induced employment associated with NGS and the Kayenta Mine allows many Navajo and Hopi workers to remain on or return to the two reservations, or live in nearby Page.[11] On both reservations, many employed workers support an extended family, increasing the standard of living for multi-generational families of workers (Arizona Rural Policy Institute 2012; Black Mesa United, Inc. 2005).

The economic and fiscal importance of NGS and the Kayenta Mine notwithstanding, there are Navajo and Hopi who are deeply concerned about cultural, environmental, and health effects of the two facilities. These concerns have given rise to social and environmental activism and the formation of organizations that advocate for cultural, environmental, and health issues, particularly in the Black Mesa area. A number of these individuals and organizations also advocate for a transition to renewable energy generation to replace NGS and help support the tribal economies.

3.18.3.1.6.2 Contemporary Sociocultural Issues

Given the 40-year history with NGS and the proposed KMC, there has been extensive discourse about the two facilities in a variety of studies, articles, interest group websites, and other secondary sources. These issues have been expressed in government-to-government consultations with the tribes, scoping comments to the EIS (see Section 1.11), and in two meetings with residents of the Kayenta and former Black Mesa mine lease area hosted by Reclamation and OSMRE at the Kayenta Mine. Reclamation provided a Navajo language interpreter at these meetings to allow residents to express their concerns in Navajo if they so desired.[12] Follow-up interviews using a Navajo language interpreter were conducted with a number of lease area residents to further explore these issues. Interviews also were conducted with tribal and off-reservation local government officials.

The following summarizes the discourse on these topics. Issues involving both NGS and the Kayenta Mine are discussed first, followed by existing conditions and specific concerns associated with NGS and the Kayenta Mine individually. The summary places the issues in the contemporary sociocultural context and, where appropriate, the discussion identifies current Navajo Nation, Hopi Tribe, federal government, SRP, and PWCC efforts to monitor and address these issues, and provides references to other sections of the EIS that address these topics.

<u>Economic Importance to the Navajo Nation and Hopi Tribe</u>

The Navajo Nation relies heavily on employment from NGS and the Kayenta Mine, and the associated lease and royalty payments (Etsitty 2014). According to former Navajo Nation President Ben Shelly, "NGS is an essential component of the Navajo Nation's economy and our energy portfolio, and must remain viable, for the sake of the Nation and our people, for years to come" (Shelly 2011).

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[11] In November of 2014 almost 89 percent of NGS employees lived on the Navajo Nation or in Page and over 79 percent of Kayenta Mine employees lived on the two reservations or in Page (PWCC 2014; SRP 2014).

[12] There are no Hopi living within the lease area.

The Hopi Tribe views NGS[13] and the Kayenta Mine as "an essential and vital element of the Tribe's current and future economy (Shingoitewa 2010), and believes that the royalties and bonuses paid by PWCC to the Tribe are an important and integral part of the Hopi economy" (Honanie 2014). In 2008, the Hopi and SRP entered into a generation performance agreement which addresses payments made by SRP to the tribe in conjunction with NGS operations (see **Appendix 1A**).

As the sources of more than 830 jobs held by Native Americans (primarily Navajo[14]), NGS and the Kayenta Mine are major employers in an area of chronically high unemployment. Purchases by NGS and the Kayenta Mine, and those by NGS and mine employees in turn generate indirect and induced jobs on the two reservations and in nearby off-reservation communities. In addition to the full time jobs at NGS, the annual overhaul activities provide between 800 and 1,200 temporary jobs, a substantial portion of which are routinely filled by members of the Navajo tribe (SRP 2016).

NGS and Kayenta Mine employees reside mainly in the northwest part of the Navajo Nation and in nearby Page, Arizona. Consequently, the direct economic effects of the two facilities' employment are fairly localized. NGS and Kayenta Mine lease payments, royalties, taxes, and other revenues also support a large percentage of the tribal jobs and programs that provide services across the two reservations. Consequently the secondary economic, employment, and service effects of the two facilities are distributed throughout both reservations.

Economic Importance to Coconino and Navajo Counties and the City of Page

NGS and the Kayenta Mine provide substantial contributions to the economies of Coconino and Navajo counties, in terms of employment, purchases of goods and services, and generation of tax revenues and other payments. Page is particularly dependent on NGS for the robustness of its economy and for its contributions to the social fabric of the community. Because of its year-round operations, NGS provides an important counterbalance to Page's other major industry – tourism and outdoor recreation, which is seasonal. The annual overhauls at NGS, which occur in the off-season for tourism, provide an important boost to local merchants and lodging and dining establishments. As a regional trade center, plant and mine employees purchase goods and services in Page. NGS workers hold political office (five Page mayors have been NGS employees) and serve on boards and committees. Spouses of NGS workers are an important source of employees for local government, schools, and businesses. Additionally NGS and its employees donate funds and volunteer time to local charitable and civic initiatives (Diak 2015; SRP 2014).

Kayenta, Tuba City, Flagstaff, Winslow, and Prescott also benefit from NGS and Kayenta Mine employee purchases of goods and services. NGS in lieu, property tax and voluntary payments are important for Coconino County, the Page Unified School District, and local special purpose and service districts. The Kayenta Mine is fiscally important for Navajo County, and the large number of mine workers (53 percent) who live in Kayenta help diversify the tourism economy in that community.

3.18.3.1.6.3 Navajo Generating Station

Concerns about NGS generally focus on the potential effects of plant emissions on air quality, visibility, climate change, and human and ecological health, including effects on endangered species. There is concern that emissions may be contaminating soil, water, and food sources. This is important to the Navajo and Hopi because some rely on subsistence farming, livestock grazing, hunting, and gathering of

[13] The Hopi Tribe views NGS and the Kayenta Mine as a single economic complex, with Hopi coal important to the overall success of the complex (Shingoitewa 2010).

[14] The Hopit Tunatya' at 2000: The Hopi Strategic Land Use and Development Plan estimated that 24 Hopi were employed at the Black Mesa and Kayenta Mines in 2000 (Hopi Office of Community Planning and Economic Development 2001).

traditional plants for part of their diet. Air quality impacts are discussed in Section 3.1, Air Quality. Agricultural and food chain effects related to NGS are discussed in Section 3.16, Public Health and Human Health Risk Assessment.

Several scoping comments expressed concern for the effects of coal combustion waste on groundwater near NGS. As noted in Section 2.2.4.4, NGS is designed to be a zero discharge facility, and has a groundwater protection plan in place. Effects of coal combustion waste are discussed in Section 3.15, Public Safety and in Section 3.7, Water Resources.

3.18.3.1.6.4 Kayenta Mine and Former Black Mesa Mine Lease Areas

As shown in **Figure 3.18-5**, most of the proposed KMC is located within the Navajo Nation. The northern part of the lease area is in the Kayenta Chapter, a small segment on the east side is in the Shonto Chapter, and the southern part is in the Forest Lake Chapter and an area of the Hopi Reservation designated as Range Unit 263.

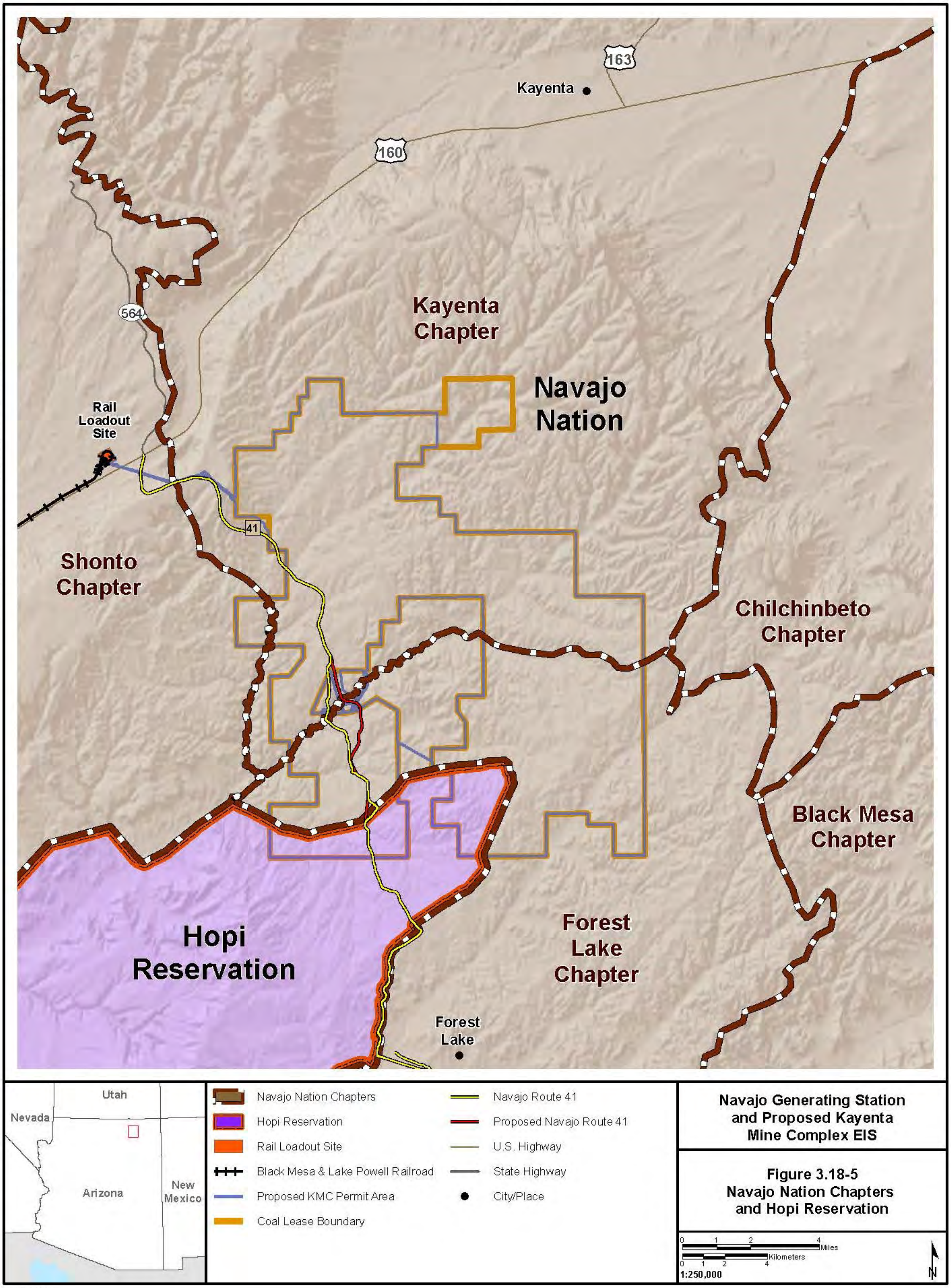
Prior to the beginning of coal mining, Black Mesa was, like much of the Navajo Nation, a remote and sparsely populated area. Residents lived in dispersed home sites, grazed livestock and raised native corn and other crops. Grazing continues in the lease area, which also supports limited, mostly subsistence-scale farming, gathering of plants, hunting, and some commercial trapping. These traditional activities are important, as are the jobs provided by the mine (Black Mesa United, Inc. 2005).

When the original coal leases were negotiated in the early 1960s, approximately one dozen extended families lived on what is now the Kayenta and former Black Mesa Mine lease area. In the intervening years, the number of households in the lease area has increased to more than 100, many of which house multiple generations and families and include the adult children or grandchildren of the original residents. Many current residents of the area work or have worked for PWCC, which has allowed them to remain in the area. (Black Mesa United, Inc. 2005; PWCC 2015d).

Within and adjacent to the lease area, residents have coexisted with surface mining since the early 1970s. Prior to the closure of the Black Mesa Mine in 2005, PWCC employed about 750 workers at the two mines. Since the closure, the Kayenta Mine has produced an average of 8 million tons of coal per year, employing over 400 workers, most of whom are Navajo, including some lease area residents. PWCC provides a variety of services for lease area residents including free coal, water, emergency fire and medical response, and road maintenance.

Lease area residents who participated in the Reclamation-sponsored meetings and interviews were of the opinion that few, if any, local residents read or spoke English when the initial lease agreements were negotiated. Local familiarity with mining came from two small nearby underground coalmines that ceased operations in the 1950s. Residents at that time reportedly believed the new mines would be similar to those small operations and would allow continued grazing in areas that would be mined. Some of the residents assert that the area’s original residents also were promised jobs, new homes, electrical and water service, paved roads, and other community services (Black Mesa United, Inc. 2010).

Beyond providing an important source of income, mining has transformed the local landscape and displaced cultural resources, traditional cultural properties, and burial sites. Lease area residents experience mining activities, heavy equipment and workforce traffic, blasting and other noise, and dust on a daily basis. Mining has displaced some residents from their homes and customary grazing areas.



Navajo Generating Station and Proposed Kayenta Mine Complex EIS

Figure 3.18-5
Navajo Nation Chapters and Hopi Reservation

7/28/2016

PWCC-supported Services and Water System Plans

Lease area residents receive a number of PWCC-supported amenities and services. Some residents of surrounding Navajo chapters and Hopi villages also receive free coal and access PWCC-provided watering stations.

All but five homes in the lease area have electrical service, but none have water service (PWCC 2015e). Lease area residents, like those in many rural parts of the Navajo Nation, must haul water for their homes and livestock. PWCC provides two public use water stations within the lease area and hauls water to some livestock tanks and residents unable to haul their own water (PWCC 2015e). Persons from outside the area also use the water station because the water is free, in contrast to that at some water stations operated by chapters, which charge for water.

The Many Mules Water Project is designed to deliver water to dispersed home sites in and near the Kayenta Mine lease area (Black Mesa Review Board [BMRB] 2015). Phase 1, of a planned four phase project, is scheduled to begin construction in 2016 and will deliver water to approximately 60 residences. PWCC agreed to allow use of an existing mine well to supply water for the project (Navajo Nation 2011). In 2013, the Navajo Nation approved $5.2 million for the project, using funds received as part of its lease agreement with PWCC (Navajo Nation 2013a). As of January 2106, an additional $4.5 million was dedicated by PWCC for Phase 2 of the Many Mules project (PWCC 2015). The BMRB (described in the following Kayenta/Black Mesa Lease Area Oversight and Planning subsection) was awarded a $300,000 Abandoned Mine Land program grant to construct bathroom additions and install plumbing in homes to be served by the Many Mules Project (BMRB 2010). Completion of the remaining three phases is contingent upon further funding (BMRB 2015).

Coal from the Kayenta Mine is made available to Navajo and Hopi from mid-October to mid-March for home heating (OSMRE 2011). Wood salvaged during clearing of areas to be mined also is made available to lease area residents free of charge. Lease area residents receive coal card coupons allowing them to obtain up to six pickup loads per year at no cost. Navajo chapter governments also are provided coupons, which are intended for distribution to the elderly and disabled. The Hopi tribe is provided 3,500 coupons per year, for distribution through the village governments. All others are charged a fee for coal. Some Navajo and Hopi purchase coal, repackage it and sell it at roadside stands or markets. PWCC has distributed over 13,000 tons of coal annually in recent years. PWCC distributes a flyer regarding the safe use of coal in the home at the coal distribution site (PWCC 2015d).

PWCC has more than 40 trained first responders on staff to respond to accidents, wildfires and emergency medical situations in and near the lease area. The Kayenta Mine first aid station is open on a 24-hour per day basis, and staffed by certified personnel. Although the station primarily is for PWCC employees, it is available to the public in life threatening situations. The station is not staffed by doctors or nurses, nor is it intended to treat routine medical conditions. PWCC hosts an annual health fair for employees and area residents, which provides routine screening such as body mass index, blood pressure, blood sugar, and blood testing for other health indicators. Flu shots also are available. Indian Health Services participates in the health fair (PWCC 2015f,g).

Including road maintenance, snowplowing, the provision of gravel, charitable contributions, and sponsorship for community events, PWCC has averaged between $750,000 and $800,000 per year in in-kind and monetary contributions to the Navajo Nation and Hopi Tribe in recent years.

Air Quality, Human Health and Safety, and Ecological Health

A common concern among lease area residents is the reported high incidence of respiratory disease, which they attribute to dust, coal dust,[15] blasting emissions, coal conveyance, and smoke from indoor heating. Many households use or have used wood and coal for heating, also a potential cause of respiratory disease. Lease area residents also are concerned about the risk of cancer from mining activities. No epidemiological studies have specifically examined health impacts resulting from mining operations in the Black Mesa area (National Renewable Energy Laboratory [NREL] 2012b), although a human health risk assessment was prepared for this EIS (see Section 3.16, Public Health and Human Health Risk Assessment). Some residents note that although mine employees have health insurance, many residents do not, but, like other Navajo living in the area, all must travel to Indian Health Service clinics in Kayenta, Tuba City, and elsewhere for health care.

There also is concern that emissions, coal dust, and fugitive dust from the mine are contaminating soil, water, and food sources for residents in and near the lease area because some rely on subsistence farming, livestock grazing, hunting, and gathering of traditional plants for part of their diet (see Section 3.16, Public Health and Human Health Risk Assessment, for a discussion of depositional effects of KMC emissions). A number of scoping comments raised concern about the effects of mining on plants and animals in and near the lease area. There are particular concerns for effects on endangered species and that mining activities may alter habitat and migration patterns for some species. These issues are discussed and addressed in Sections 3.10 through 3.13. Generally, ecological health is linked to air quality, water quality and quantity, habitat and migratory corridor use, and reclamation which are discussed in the corresponding sections of the EIS.

Although security gates prevent public access to roads in the active mine areas, some area residents have voiced concerns about traffic accidents and the risk associated with heavy equipment and personal vehicles sharing access roads leading to mine facilities and active mining areas.

Water Quantity and Quality Concerns

A number of Navajo, Hopi, and non-governmental organizations (NGOs) expressed concern that ongoing water use at the Kayenta Mine combined with historic pumping of the Navajo Aquifer (N-Aquifer) to supply the former Black Mesa Mine and Black Mesa coal-slurry pipeline has substantially depleted the N-Aquifer, with associated adverse effects on springs, seeps, and wells in the Black Mesa area.

The arid climate, periodic drought, concern about climate change, and traditional values regarding water heighten the importance of water issues in the Black Mesa area. The N-Aquifer is the primary and in many instances, the only source of drinking water on the Hopi Reservation, and on parts of the Navajo Nation on and near Black Mesa. Moreover, springs and seeps in the area are culturally important and water in general has a key religious significance for both tribes (see the Native American Traditional Values sub-section below). Some lease area residents also are concerned that surface mining has altered aquifers, resulting in loss of springs.

Section 3.7, Water Resources, describes the surface water and groundwater monitoring programs in place at the Kayenta Mine. These programs are administered by the Navajo Nation, the Hopi Tribe, OSMRE and U.S. Environmental Protection Agency. Section 1.7.2.1 describes water control facilities associated with the Kayenta Mine.

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[15] Coal stockpiles and coal handling facilities are cited by some residents as sources of coal dust.

Relocation and Compensation

The relocation of Navajo living within the Kayenta Mine and former Black Mesa Mine areas is a concern for some lease area residents. Navajo are traditionally a matrilineal and matrilocal society, meaning property descends through females, daughters establish homes close to their mothers, and their husbands come to live on their wife's lands (Lyon 2003). Traditionally, a baby's umbilical cord is buried near the birthplace, and according to Navajo culture, that practice creates a strong attachment to a person's home area. Family members who move away for educational or employment purposes often return to live near their families, which promotes family cohesion and allows the transmittal of traditional cultural practices from one generation to the next.

In the Kayenta and former Black Mesa Mine area, PWCC leases with the tribes require that residents are relocated if their residences fall within the required minimum separation distance between mining activities and occupied buildings. PWCC, in cooperation with the affected parties and according to tribally approved procedures, either provides a replacement home on a mutually agreed upon location, or compensates the owner with a negotiated lump sum payment for the value of all structures. The resident is given the choice of relocation to a replacement home or monetary compensation. PWCC negotiates directly with the homeowner for relocation of households. To date there have been no involuntary relocations within the lease area. In instances involving relocation, PWCC works with the Navajo Nation Land Department to help the homeowner secure a new homesite lease and pays for surveys, cultural and environmental clearances, and site grading. In addition to constructing new residences and improvements, PWCC installs cisterns and septic systems, and prepares the home for water and electrical service. PWCC attempts to relocate residents within their customary use areas (i.e., where grazing takes place or where sociocultural ties exist); however, some residents have chosen to be relocated to distant communities such as Kayenta, Chinle, Window Rock, and elsewhere (PWCC 2015e,h).

Since 1970, 27 households have relocated and received replacement residences and improvements, and another five have relocated temporarily. A total of 13 households have received lump sum compensation for their residences and 56 have been compensated for other improvements. Four households were compensated for inconvenience during the 1980s (PWCC 2015h).

During the 1970s and early 1980s, most residents chose to receive lump sum compensation for residences and improvements on land withdrawn for mining use. A few chose to be relocated and provided with replacement homes. Most residents who were compensated or received replacement homes during that period are now deceased (PWCC 2015e,h). PWCC compensated residents for the appraised value of existing homes. Some residents who were compensated for their homes during the 1970s and 1980s have stated that the compensation was inadequate to fund construction of new homes.

Some lease area residents who were relocated said that they had springs or ponds at their original locations but water was not available at their replacement home site. Others report moving more than once due to mining activities. Some residents state that although their lands were not taken for mining, the proximity to mining activities compelled them to move.

When grazing lands are to be withdrawn for mining, PWCC coordinates with the grazing permit holder and the Navajo Nation Land Department. PWCC compensates grazing permit holders for any acreage withdrawn from a customary use area for mining. The rate of compensation for such withdrawals was determined in discussions between PWCC and the Navajo Nation. Currently compensation is paid in 5-year increments at the beginning of each 5-year period, until mining is completed and the land is reclaimed and returned to the Navajo Nation (PWCC 2015e).

3.18.3.1.6.5 Homesite Leases

Individual Navajo households may construct a home on rural portions of the Navajo Nation. To build a home or receive electrical or water service to an existing home on the Navajo Nation requires a Navajo Nation Land Department homesite lease. If the desired homesite is located within a grazing permit area, as most dispersed housing is, the prospective homeowner must obtain permission from the Chapter grazing board and the grazing permit holder. The lease applications undergo review by the Navajo Nation Environmental Protection Agency, Navajo Department of Fish and Wildlife, and the Navajo Nation Historic Preservation Department. These agencies review human health considerations, and potential impacts to biological and cultural resources, when issuing homesite leases (Navajo Nation 2015b). The Navajo Nation has authority to issue homesite leases under the General Leasing Act; however, currently the BIA continues to issue the leases.

Obtaining a homesite lease is reportedly difficult across the Navajo Nation. Within the PWCC lease area, homesite leases are not currently being approved (PWCC 2015d,e).

According to some lease area residents, the inability to obtain homesite leases has resulted in overcrowding of residences and stress on families whose adult children desire to establish residences near their parents' homes.

3.18.3.1.6.6 Structural Damage to Homes

Some residents of the Black Mesa area report broken windows and cracks in their walls and foundations, which they attribute to mining-related blasting.

Blasting operations at the Kayenta Mine are conducted in accordance with Federal law, applicable regulations, and the approved mine permit application. Under federal requirements (30 Code of Federal Regulations Part 816.62), a resident or owner of a dwelling or structure inside or within 0.5 mile of the permit area may request a pre-blasting survey be conducted. Upon receipt of such a request, Peabody conducts a survey analyzing the conditions of the structure prior to blasting activities, documenting any pre-blasting damage and other physical factors that could be affected by the blasting. A written report is prepared and copy provided to the OSMRE and the person requesting the survey.

Procedures for controlling adverse effects of blasting are specified under 30 Code of Federal Regulations Part 816.67. Although federal law and regulations allow mining up to 300 feet from an occupied dwelling, the Kayenta Mine permit prohibits blasting within 0.5 mile of an occupied dwelling. Residents are notified in advance of the blasting schedule, notices are posted in public locations, and residents near the blasting area are evacuated prior to any blasting. Blasts are monitored for air blast and ground vibration twice per year in June and December. PWCC monitors air blast and ground vibration for all shots exceeding the scaled distance equation, as well as any required by the regulatory authority at their requested location. OSMRE reviews Kayenta Mine's blasting records monthly during field inspections (PWCC 2012 et seq.).

3.18.3.1.6.7 Employment

The Kayenta Mine is by the dominant private sector employer in the area, providing well-paying jobs that would be otherwise unavailable locally. At the time of this assessment, many lease area residents have, or have had jobs with PWCC or its contractors. Mine-related employment is economically important and has raised the material standard of living for many lease area households. More than 400 mining jobs were lost when the former Black Mesa Mine closed.

Some lease area residents report difficulties in obtaining employment at the mine. PWCC's requirements for new hires vary depending on the position being filled. Some require prior experience, education, and training, others require only a high-school education. PWCC fills approximately five positions annually in response to retirement, termination for cause, or voluntary departure by the employee. Most current employees have over 20 years tenure at the mine and turnover rates are low (PWCC 2014).

3.18.3.1.6.8 Lease Area Roads

As noted in Section 2.3.1.4, PWCC maintains the paved portion of N-41 from its intersection with U.S. Highway 160 to the former Black Mesa Mine; the remainder of the route is not routinely maintained. Overall, PWCC maintains 173 miles of roads within the lease area. All roads are signed and maintained through periodic grading and dust suppression. Security gates prevent public access on roads in the active mine areas. PWCC security vehicles escort school buses and delivery vehicles within the gated parts of the mine (OSMRE 2011). After a snowstorm, PWCC first plows N-41, then school bus routes, and then other roads including those leading to dispersed home sites. Roads to home sites may not be plowed for several days after a large snowstorm (PWCC 2015f). PWCC is not obligated to plow roads leading to homesites, but does so as a courtesy to lease area residents.

Some residents state that N-41, from the former Black Mesa Mine facilities to the southern lease area boundary, and the Kayenta Mine road should both be paved for safety and dust control reasons. Residents also would like to see the paved portion of N-41 realigned and improved to higher standards.

Dust in the southern portion of the lease area is often associated with trucks hauling gravel from the southern part of the lease area for the Red Dog Gravel Project, an intergovernmental partnership of the Navajo Nation Department of Transportation, Navajo County, BIA, PWCC, the Pinon and Kayenta school districts, and 10 local chapters (Navajo Nation Office of the President and Vice President and Navajo County Board of Supervisors 2013).

No formalized agreement for maintenance of the paved portion of N-41 exists with the BIA, but PWCC maintains roadway shoulders and drainage, and coordinates with the Navajo Nation Department of Transportation for repaving or seal coating of the route. PWCC graveled 13 miles of N-41 from the end of the pavement south to Dinnebito Wash and prepared it to be paved. The Navajo Nation Road Department has considered completing the paving, but project funding has not been identified (PWCC 2015e).

Local residents noted that some roads and drainage crossings in the lease area become impassable following heavy rains, and although main access roads are quickly repaired, repairs on other roads frequently take longer, preventing residents from entering or leaving their homes and property. As noted above, PWCC is not obligated to repair roads leading to homesites, but does so as a courtesy to lease area residents.

3.18.3.1.6.9 Cultural Resources

Some residents and others have expressed concern for past treatment of cultural properties, the adequacy of cultural surveys, and the disturbance of TCPs and sacred/historic sites. Some but not all Navajo and Hopi would like to see items and burial remains that have been stored off-reservation returned to the respective tribes. According to some lease area resident comments, sacred sites and burials that residents were told would not be disturbed have been removed or destroyed by mining activities.

Section 3.17, Cultural Resources, describes the legal framework for documentation, evaluation, and protection of cultural resources, and describes historic and current programs for: 1) inventorying cultural resources, and 2) resolving adverse effects on historic properties.

3.18.3.1.6.10 Reclamation and Grazing

Some lease area residents are concerned about the pace and adequacy of reclamation of previously mined areas. Concerns include insufficient topsoil and inadequate erosion control. Some residents have stated a preference for a primary reclamation for grazing; others prefer returning disturbed land to its original vegetative state using nursery-grown native plants. Some residents have voiced concern about the current status of reclamation of former Black Mesa Mine buildings and facilities. Some residents also are concerned that mining has altered the terrain to the point that springs have stopped flowing and flooding occurs in new places.

PWCC's existing reclamation program, including ongoing monitoring and restoration for the reclaimed areas at the former Black Mesa Mine, is included in **Appendix 1D**. Environmental monitoring and reclamation activities are reported annually by PWCC to the OSMRE in a joint report prepared for the Kayenta and former Black Mesa Mine area. All Kayenta and former Black Mesa Mine reclaimed areas are managed to return a stable, productive and sustainable resource that meets post-mine land use goals of grazing, wildlife habitat, and restoration of plants that have cultural, medicinal, and ceremonial significance to the Navajo Nation and Hopi Tribe. PWCC is responsible by regulation and lease commitments to reclaim lands disturbed by mining to a condition compatible with and capable of supporting the post-mining land uses (Black Mesa United, Inc. 2010).

Livestock raising and grazing are culturally important for traditional Navajo. Overgrazing has been an ongoing concern throughout the Navajo Nation for years (Redsteer et al. 2015). A shortage of grazing lands and available forage have resulted in some Navajo having to purchase hay or transport their livestock to other areas for grazing, increasing costs to the point that raising livestock is no longer viable for some. Overgrazing and trespass on grazing areas are particularly troubling within the lease area because of the need to allow reclaimed areas to reestablish, and because withdrawal of grazing land on the lease area has resulted in competition for grazing land in other areas. As noted above (see the Relocation and Compensation subsection), PWCC compensates grazing permit holders for acreage withdrawn from a customary use area for mining.

In 2015, PWCC, with the support of BIA, the Navajo Nation, and working efforts from local community chapters, temporarily suspended grazing on all reclaimed areas to allow reclaimed land to recover from the effects of drought and overgrazing (PWCC 2015i).

3.18.3.1.6.11 Hopi Employment at the Navajo Generating Station and Kayenta Mine

The Hopi Tribe has expressed concern that few Hopi have jobs at NGS or the Kayenta Mine, in contrast to the large number of Navajo workers at both facilities. The small number of Hopi workers is in part attributable to the Navajo preference at NGS, and the long travel distances between Hopi villages and both NGS and the Kayenta Mine, and the poor condition of the roads that provide access to the mine from most locations on the Hopi Reservation.

3.18.3.1.6.12 Equity Concerns

A key concern for some lease area residents involves the perceived inequity of mining coal on Black Mesa for the generation of power for use in distant cities and to support the pumping of water to Phoenix, Tucson, and surrounding farms and reservations, while lease area residents do not have water service to their own homes, and are subject to the effects and risks of mining. The power and water delivery made possible by coal from the Kayenta Mine enables economic growth and an improved quality of life for residents of those distant municipal, tribal, and agricultural areas, and the economic and fiscal benefits of coal production accrue to the Navajo Nation, Hopi Tribe and other residents of North Central Arizona. Conversely, the effects of mining, some of which are locally perceived as adverse, fall on the people living near the Kayenta and former Black Mesa mines.

The Navajo Nation Energy Policy of 2013 states that "Communities impacted by energy development will have the opportunity to provide input on and indicate their support for such projects, and where substantially and adversely impacted by the development, to share in a portion of the financial benefits of such projects" (Navajo Nation 2013b).

As noted earlier in Section 3.18.3.1, in Navajo Nation and Hopi Tribe scoping comments and elsewhere, the Kayenta Mine contributes substantially to the economies and operations of the Navajo Nation and Hopi Tribe, through direct employment (primarily Navajo workers), benefits paid to retired workers in the area, and royalties, bonuses, and other payments, which support many jobs and services throughout the Navajo Nation and Hopi Reservation. Although Navajo tribal services are available to all Navajo living on the Navajo Nation, residents of dispersed areas, including the Kayenta and former Black Mesa Mine lease area, must travel considerable distances to access those services.

Residents of the Kayenta and former Black Mesa Mine lease area receive some PWCC-provided services and benefits including free coal, access to free water and to distribution sites, road maintenance, and emergency medical services, and some but not all households within and near the lease area have a family member employed at the mine.

3.18.3.1.6.13 Social and Community Change

Social and community change across the Navajo Nation and Hopi Reservation has resulted in part from the influences identified in the above Sociocultural Setting subsection. The introduction of mining has resulted in additional changes in the Kayenta and former Black Mesa mine lease area.

Changes noted by lease area residents include the improved access to the area, which has made it easier to get onto Black Mesa for residents and nonresidents alike. A number of local residents observed that nonresidents who come to the lease area to obtain free firewood or water, to purchase coal, or for other reasons sometimes dump trash, cut fences, and abandon dogs and cats.

Residents observed that closure of mining areas and withdrawal of grazing lands has resulted in tension between permittees and trespass on customary use areas. Closure of active mining areas also complicates access across the lease area. A number of older lease area residents report that the lease area community is less cohesive today than before mining.

While some lease area residents have jobs at the mine, others do not. Some lease area residents report tension between residents that support and those that oppose mining. But a substantial percentage of lease area residents who offered comments in the listening sessions stated that while mining jobs and PWCC-provided amenities and services were important, they were concerned about the mine's impact on their health, and wanted more jobs for residents, road improvements, improved road safety, and in-home access to water. Many residents stated that they wanted a voice in the way that mining occurs on their traditional lands.

3.18.3.1.6.14 Mine Lease Area Oversight and Planning

The BMRB, established by Navajo Tribal Resolution (CN-101-72), is chartered to "advocate for fair and just compensation for Navajo families within the five Navajo Nation chapters[16] whose socio-economic and environmental interests are adversely affected or impacted by coal mining and related operations of PWCC, as authorized and provided for by the company's two coal mining leases with the Navajo Nation… The Board may make appropriate recommendations to the President of the Navajo Nation, the Navajo Nation Council, the Resources Committee of the Navajo Nation Council, or to PWCC, concerning the health, social welfare, education, and environment of the Navajo People affected by any of PWCC's mining and post mining or related operations" (2 N.N.C. §901-910). The BMRB vision statement is "… to advocate for the best interest of the local families within the leased area of PWCC and to utilize the available resources to enhance the quality of life and restore harmony and balance for the people and the land."

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[16] Black Mesa, Chilchinbeto, Forest Lake, Kayenta, and Shonto.

There are concerns that while the BMRB is charged with advocating for lease area residents, the funding provided by the Navajo Nation is not adequate to carry out the BMRB's mandate (BMRB 2015; Black Mesa United, Inc. 2010). Recent activities for the BMRB have included planning and seeking funds for the Many Mules Water Project as described in a preceding subsection.

The Navajo Nation, in cooperation with residents of the Kayenta/Black Mesa lease area have conducted land use planning for the post mining use of the lease area. Beginning in 2003, the Speaker of the Navajo Nation Council met with lease area residents to discuss the future closure of the two mines. The Black Mesa– Kayenta Lease area Land Use and Community Development Plan (Plan) was subsequently authorized and completed in December of 2005.

The first goal of the Plan is to "Provide the ability to address needs through a self-governing body for the leasehold community." In January 2007, the BMRB adopted implementation of the plan as its primary goal. In November 2008, BMRB hosted a meeting for Kayenta/Black Mesa lease area residents to promote the establishment of a self-governance organization. The lease area was divided into sectors and each sector was encouraged to start meeting and to elect officers. As a result of these grassroots meetings, Black Mesa United-Dzilijiin Bee Ahota Incorporated (Black Mesa United, Inc.) was created on November 15, 2009, and officially incorporated under the Arizona Corporation Commission on December 22, 2009. Black Mesa United, Inc. applied and received a Navajo Nation Corporation Code Certificate of Authority on March 30, 2010 (Black Mesa United, Inc. n.d.). The organization is working toward achieving non-profit status under Section 501(c) (3) of the U.S Internal Revenue Code, and currently functions as an advocacy group for lease area residents. As with the BMRB, a lack of funding and professional staff has impeded progress toward the goals of the 2010 plan.

3.18.3.1.7 Native American Traditional Values and Concerns

This section addresses traditional values of affected Native American communities, to the extent that such values have been identified during scoping, government-to-government consultations, and/or community and individual interviews. The Navajo and Hopi, the two primarily affected tribes, provided substantial comments and input relative to traditional values and that information serves as the basis for much of the analysis in this section. Concerns about effects on traditional values of the tribes affected by transmission and communication sites and the CAP have not been identified for any alternative. Reclamation will continue to accept and consider input on effects to traditional values from any affected tribe for any aspect of the NGS-KMC Project.

3.18.3.1.7.1 Regulatory Overview

In addition to the regulation and guidance noted in Section 3.18.1, the following federal guidance is particularly pertinent to the consideration of traditional values.

- The Secretarial Order on American Indian Tribal Rights, Federal-Tribal Trust Responsibility, and the Endangered Species Act (SO 3206) states, "…Long-standing Congressional and Administrative policies promote tribal self-government, self-sufficiency, and self-determination, recognizing and endorsing the fundamental rights of tribes to set their own priorities and make decisions affecting their resources and distinctive ways of life. …The Departments shall be sensitive to the fact that Indian cultures, religions, and spirituality often involve ceremonial and medicinal uses of plants, animals, and specific geographic places (Secretary of the Interior and Secretary of Commerce 1997).
- Reclamation's Indian Policy states "Reclamation will provide Indian tribes the opportunity to be involved early in the process when considering actions that may affect their religion or culture. Reclamation will show respect for tribal cultural values" (Reclamation 1998).

3.18.3.1.7.2 Tribal Regulations, Policies, and Plans

While not always applicable to NGS based on the Covenant Not to Regulate in the1969 Lease (see **Appendix 1A**), tribal law provides important context to traditional views and values, as summarized below for the Navajo and Hopi.

<u>Navajo Nation Cultural Resources Protection Act</u>

The Navajo Nation Cultural Resources Protection Act [Navajo Tribal Code CMY-19-88] applies on surface lands controlled by the Navajo Nation. The Navajo Nation Cultural Resources Protection Act states that "…the spirit and direction of the Navajo Nation are founded upon and reflected in its cultural heritage; The cultural heritage of the Navajo Nation should be preserved as a living part of our community life and development in order to give a sense of orientation to the Navajo People; The preservation of this irreplaceable cultural heritage is in the interest of the Navajo Nation and its people so that its vital legacy of cultural, educational, esthetic, inspirational, economic, and energy benefits will be maintained and enriched for future generations of Navajos." It establishes as policy the use of appropriate measures to foster conditions under which modern Navajo society and its cultural resources can coexist in productive harmony to fulfill the social, economic, and other requirements of present and future generations. It also ensures the protection of cultural properties by mandating consultation with and approval from the Tribal Historic Preservation Officer of all ground disturbing activities.

<u>Navajo Nation Environmental Policy Act</u>

This Navajo act establishes that the Navajo Nation's policy is to "promote harmony and balance between the natural environment and people of the Navajo Nation, and to restore that harmony and balance as necessary. To this end, the Navajo Nation Council declares that the protection, restoration and preservation of the environment is a central component of the philosophy of the Navajo Nation; that the quality of life of the Navajo People is intimately related to the quality of the environment within the Navajo Nation." This act embodies the importance of sustainability of the natural environment while serving the Navajo Nation people's best interest in areas such as economic development and growth revenue.

<u>Navajo Nation Energy Policy</u>

The Navajo Nation's 2013 Energy Policy, Section 5, states "Chapter 2 of the Navajo Nation Code entitled The Foundation of the Dine', Dine' Law, and Dine' Government describes the four sacred elements of life as air, light/fire, water, and earth/pollen and provides that in all their forms [they] must be respected, honored, and protected for they sustain life. Recognizing the sacredness of these elements, the Nation desires to establish a sustainable energy economy based on the Nation's human capital, natural resources, capital resources and the exercise of its inherent sovereign authorities. A sustainable Energy Economy ensures an acceptable quality of life for Navajo people; proper planning and management by governmental officials; energy security; environmental stewardship; adequate rents, royalties, bonuses and taxes to ensure benefits for a sustainable Nation" (Navajo Nation 2013).

<u>Hopi Ordinance 26: Ordinance for the Protection of Places and Objects of Sacred, Historical and Scientific Interest on the Hopi Reservation</u>

As noted in Section 3.17.2 and **Table 3.17-2**, Hopi Ordinance 26 applies on surface lands controlled by the Hopi Tribe. The purpose of this law is to protect sites, locations, structures, and objects of a sacred, historical, or scientific interest or nature on lands within the jurisdiction of the Hopi Tribe from desecration, destruction, theft, or other harm or interference.

<u>Hopit Pötskwaniat (Hopi Tribal Consolidated Strategic Plan) 2011</u>

The Plan was adopted by the Hopi Tribal Council on November 29, 2011, to serve as the principle direction for the Hopi Tribe. The goals for Mineral Resources are:

- To ensure proper management of energy and mineral resources on Hopi lands.
- To diversify energy development.
- Create a Department/Company to Develop Energy and Mineral Resources.

3.18.3.1.7.3 Navajo Traditional Values

The official expression of Navajo traditional values is embodied in Traditional Law, Customary Law, Natural Law, and Common Law. Collectively, these four laws declare the fundamental beliefs and traditional practices that must be honored and protected to ensure the continuance of the Navajo people. Among these are the responsibilities of the Diné to the universe and its resources by practicing the Diné Life Way, and the obligation of the Diné to uphold ceremonial and oral histories for the protection and preservation of the beauty, harmony, and balance of the natural world for future generations, Nihook'a Dine'e' Bila Ashdla'ii, or the earth surface people as referred to within Diné culture, have intimately interacted within the landscape known as Dzil Ijiin or Black Mesa, as ecological stewards and ceremonial custodians since time immemorial. Historical Diné ways of interacting with the land-base can be understood through the fundamental, natural and sacred ceremonial laws bestowed upon the Diné since the beginning of the emergence of the first world or Ni hodilil (Black World).

3.18.3.1.7.4 Hopi Traditional Values

This portion on Hopi traditional values is excerpted from the Hopi Worldview Summary (Hopkins et al. 2016), which was prepared with the participation of the Hopi Cultural Preservation Office.

> "Hopi traditional teachings underscore the necessary and intrinsic relationship that exists between the earth, the elements, plants, animals, and humans. Hopi culture has developed in interdependence with the earth and its elements, and Hopis believe that the central role of their religious practices is to keep the universe in balance. Hopis view the earth as sacred, and they view themselves as stewards rather than masters."

The Hopi world view and traditional values specifically assign special importance to water, ancestral sites and human remains, plants, animals, minerals, and the spatial context of cultural knowledge.

3.18.3.1.7.5 Navajo and Hopi Traditional Values in the Context of Coal Mining and Electric Power Generation

Based on scoping comments received from Navajo and Hopi individuals, the Hopi Tribe, from individual Navajo residents of the proposed KMC area during listening sessions, and review of articles, interest group websites, and other secondary sources, some Navajo and Hopi clearly consider mining and burning coal for electric power generation to be incompatible with their respective traditional values.

Other comments, the aforementioned review, and the 40-year history of Navajo and Hopi tribal governments approving leases for NGS and the Kayenta and former Black Mesa mines, indicate that there is a continuum of opinions ranging from 'compatibility' to 'incompatibility' with traditional values of mining and electrical power generation amongst some Navajo and Hopi. For some Navajo and Hopi, the economic, employment, and fiscal benefits associated with mining and electrical power generation also are important when considering the use of tribal resources. In the case of the Navajo, Sections 4, 5, and 9 of the 2013 Navajo Nation Energy Policy, which was passed by a majority of the Navajo Nation Council, suggest that this is the case.

The numbers of Navajo and Hopi who believe that mining and burning coal for electric power generation is or is not compatible with their respective traditional values, or who believe such activities can be compatible and also merit consideration for their economic, employment, and fiscal benefits are not known. This topic has been a source of controversy within each of the tribes for decades.

3.18.3.2 Transmission Systems and Communication Sites

As noted in Section 1.8, the WTS and STS transmission systems traverse land owned or managed by a combination of private, tribal, and governmental agencies. There are 19 radio communication sites supporting operations of the plant, railroad, and transmission systems. Construction of the transmission and communications facilities occurred in the 1970s, coinciding with the in-service dates of the NGS. Together these systems provide redundant capacity to the CAP and the reliability necessary to meet the CAP's continuous pumping demand. No new major construction is foreseen through 2019. Routine and emergency maintenance approved by previous licensing will continue.

The WTS is approximately 275 miles in length, on an alignment across northern Arizona and southern Utah, passing south of Kanab (Utah), Fredonia (Arizona) and St. George (Utah), crossing a portion of Pipe Springs National Monument in the process. West of St. George the WTS is collocated with pipelines and other transmission lines in a Bureau of Land Management (BLM) corridor through the Virgin River Gorge and along the Interstate 15 corridor northeast of Las Vegas. From there the alignment runs west of the Lake Mead National Recreation Area, terminating at the McCullough substation southwest of Boulder City, Nevada. The WTS ROW crosses portions of the Navajo, Kaibab Paiute, and Moapa Paiute reservations, the latter within a BLM reserved ROW corridor. The ROW crosses BLM, U.S. Forest Service, and state leased and private lands in Coconino County, Arizona, Kane and Washington counties in Utah, and Clark County, Nevada.

The STS is approximately 257 miles in length and located entirely within Arizona. The STS alignment generally runs south from NGS through four Navajo Nation chapters, before turning westerly in the vicinity of Cameron passing to the north and west of the San Francisco Peaks and Flagstaff. The ROW continues southward through the Kaibab and Prescott National Forests, terminating at the Westwing (Arizona Public Service Company) substation in the northwestern portion of the Phoenix metropolitan area. The area surrounding that substation was relatively rural when the power line and substation were built but has since become urbanized. Along its route, the STS ROW crosses portions of the Navajo Nation and federal, state and private lands in Coconino, Yavapai, and Maricopa counties.

SRP records indicate there is a total area of approximately 15,849 acres of ROW for the two transmission lines, associated substations and the communications sites. Of the total, approximately 25.9 percent is tribal land, principally on the Navajo Nation, 46.8 percent is federally managed land, and the remainder is a combination of state, municipal and private lands (SRP 2015).

No new major construction is foreseen before 2020. Current and foreseeable economic activity associated with these systems consists of normal operations and routine and emergency maintenance. Typically these functions are coordinated from centralized office, with crews dispatched to specific locations as necessary. Consequently, these activities would not be expected to result in additional local employment, changes in population, housing demand, demands for public facilities and services or changes in fiscal conditions.

Transmission and generation facilities generate land use revenues to property owners and local and federal land holding agencies on which the ROW are located. This is true for the WTS and STS, although a provision of the Secretarial agreement authorizing the use of BLM and U.S. Forest Service lands provided for special treatment of revenues due for use of those lands. The provision allowed the Regional Director of the Bureau of Reclamation to determine whether rents due should be paid, or should be credited against the obligation of the U.S. for its portion of the construction and operation of the project, and this crediting option has been exercised. Total annual land use revenues for all landowners and agencies are not known, as there is no consolidated reporting of these payments. However, an annual land use rental fee of $100 per acre can be accepted as an approximate average value over the project, and annual land use rentals to all parties can be assumed to be in the $400,000 to $500,000 range. There is no anticipation that land use charges would change through 2019.

To the extent not exempted by statute or regulations, transmission lines and communications facilities are subject to local property taxes. Exemptions include the federal share of the two lines as well as SRP's share, the latter due to SRP's status as an agricultural improvement district under Arizona law. SRP voluntarily adopted a policy to remit payments in lieu of taxes to local property taxing entities, including the Navajo Nation. The other co-tenants are responsible for submitting payments to the appropriate counties and tribal entities. As with the lease payments, there is no readily available central or consolidated reporting of the property tax payments for the transmission systems and communications sites. Such payments would continue through the end of 2019.

3.18.3.3 Central and Southern Arizona – Area of Indirect Socioeconomic Effect

The 336-mile-long CAP system originates at the Mark Wilmer pumping plant on Lake Havasu in La Paz County. Water deliveries are made to municipal and industrial (M&I) water users, agricultural users, and CAP tribes in Maricopa, Pinal, and Pima counties, Arizona.[17] The CAP was authorized by the 1968 Colorado River Basin Project Act; construction began in 1973 and was substantially completed 20 years later. The original vision for the CAP was primarily to deliver water for use as agricultural irrigation water and thereby reduce demand for groundwater pumping that contributed to subsidence across the region. Higher than anticipated construction costs and rising demand for M&I water associated with rapid population growth in central Arizona raised the emphasis on M&I project (Reclamation 2000).

The Central Arizona Water Conservation District (CAWCD) is the operating entity of the CAP. CAWCD is a special district created to manage, operate and maintain the CAP and provide a means to repay the federal government for the CAP's reimbursable construction costs, including interest. CAP's annual Colorado River withdrawals averaged about 1.6 million acre-feet per year in recent years. The majority of CAP's water deliveries occur in the Phoenix area. Between 1985 and 2010 the combined population of Maricopa, Pinal and Pima counties more than doubled to 5.2 million (BEA 2014a). Water availability has been critical to that economic expansion and population growth.

In 2010 the 10 tribes with CAP water allocation had a combined on-reservation population of 57,973. That total represented a combined gain of 1,954 (3.5 percent) as compared to 2000. The White Mountain Apache had the largest on-reservation population, 13,409, the Tonto Apache the smallest, 120 residents. Among the 10 reservations, four had population declines between 2000 and 2010; the others registering gains (**Table 3.18-23**).

Table 3.18-23 Population 2000 and 2010, Indian Tribes with CAP Water Allocations and Counties in Central and Southern Arizona

Tribe/Community	Population			Percent Change
	2000	2010	Change	
CAP-affected Tribes				
Ak-Chin	742	1,001	259	34.9
Fort McDowell Yavapai	824	971	147	17.8
Gila River Indian Community	11,257	11,712	455	4.0
Salt River Pima – Maricopa	6,405	6,289	-116	-1.8
San Carlos Apache [2]	9,385	10,068	683	7.3
Tonto Apache [2]	132	120	-12	-9.1
Yavapai Apache [2]	743	718	-25	-3.4

[17] Additional information regarding the CAP and its relationship to the NGS is contained under Background, Section 1.3 in the body of the EIS.

Table 3.18-23 Population 2000 and 2010, Indian Tribes with CAP Water Allocations and Counties in Central and Southern Arizona

Tribe/Community	Population 2000	Population 2010	Population Change	Percent Change
Pascua Yaqui	3,315	3,484	169	5.1
Tohono O'odham	10,787	10,201	-586	-5.4
White Mountain Apache [2]	12,429	13,409	980	7.9
Combined Population of the Reservations	**56,019**	**57,973**	**1,954**	**3.5**
Counties				
Maricopa County, Arizona [1]	3,072,149	3,817,117	744,968	24.2
Pinal County, Arizona [1]	179,727	375,770	196,043	109.1
Pima County, Arizona [1]	843,746	980,263	136,517	16.2
Three-county total	**4,095,622**	**5,173,150**	**1,077,528**	**26.3**
Arizona	5,130,632	6,392,017	1,261,385	24.6

[1] The populations shown for these counties include residents living on the relevant portions of the reservations located in the county.

[2] These tribes/reservations are located outside of the CAP service area and could only receive CAP water via an exchange; therefore, the counties in which they are located are not included in the lower portion of this table.

Source: U.S. Census Bureau 2010, 2000.

The 10 CAP-affected tribes have reservations with a combined land area totaling 6,765,982 acres and annual CAP water allocations of 575,906 acre-feet per year (**Table 3.18-24**). These allocations carry high seniority that effectively insulate the tribes from curtailment except under extreme shortage conditions on the Colorado River. Agricultural irrigation is the primary intended use for most Indian allocations, the remainder intended to sustain the water needs of a tribal homeland. Such needs are largely discretionary and can include residential, commercial and industrial uses, and cultural and recreation uses. Some tribes have the option to lease their water rights to other users, which several tribes have done.

Table 3.18-24 Tribes with CAP Water Allocations

Tribe / Reservation	County	Reservation Land Area (acres)	Annual CAP Water Allocation (acre-feet)	Obtained through Water Settlement
Ak-Chin Indian Community	Pinal	21,840	75,000 [1] (up to 85,000 if available)	Yes
Fort McDowell Yavapai Nation	Maricopa	24,680	18,233	Yes
Gila River Indian Community	Maricopa and Pinal	371,933	311,800	Yes
Pascua Yaqui Tribe	Pima	892	500	No
Salt River Pima-Maricopa Indian Community	Maricopa	52,729	39,200	Yes
San Carlos Apache Tribe	Gila and Graham	1,853,841	30,845 [2]	Yes

Table 3.18-24 Tribes with CAP Water Allocations

Tribe / Reservation	County	Reservation Land Area (acres)	Annual CAP Water Allocation (acre-feet)	Obtained through Water Settlement
Tohono O'odham Nation	Pinal and Pima	2,774,370	74,000	Yes, except for 8,000 acre-feet
Tonto Apache Tribe	Gila	85	128	No
White Mountain Apache	Navajo, Gila, Apache	1,664,972	25,000	Yes
Yavapai-Apache Nation	Yavapai	640	1,200	No
TOTALS	**—**	**6,765,982**	**575,906**	

Residents on the CAP-related Indian reservations, generally report household incomes below comparable statewide and national values, poverty rates above the statewide and national rates, and higher dependency on public assistance (**Table 3.18-25**). Poverty rates and median household incomes on the reservations also were substantially higher and lower, respectively, than those of the general populations in Maricopa, Pinal and Pima counties.

Table 3.18-25 Income Characteristics of CAP-related Indian Reservation Residents

Tribe / Geographic Unit	Median Household Income	Household Income Less than $25,000 in 2010 (%)	Households With Public Assistance (%)	Persons Below Poverty Level (%)
Ak-Chin	$32,022	37.9	30.6	42.4
Fort McDowell Yavapai	$51,157	32.4	1.7	18.8
Gila River Indian Community	$28,779	44.6	33.3	47.8
Pascua Yaqui	$31,875	41.8	49.4	14.8
Yavapai-Apache	$27,600	37.8	20.7	42.4
Salt River Pima-Maricopa	$31,892	36.9	13.0	21.5
San Carlos Apache	$26,915	46.0	44.3	46.0
Tohono O'odham Nation	$27,040	45.5	35.4	41.2
Tonto Apache Tribe	$16,667	71.4	(na)	51.8
Maricopa County	$55,054	20.1	8.3	13.9
Pinal County	$51,310	21.6	10.3	13.5
Pima County	$45,521	26.4	11.0	16.4
State of Arizona	$50,448	22.9	9.8	15.3
U.S.	$51,914	23.5	15.8	13.8

3.18.3.3.1 Economic Conditions

Arizona's economy produced an estimated average gross domestic product of approximately $270 billion from 2010 through 2013. The state's economy primarily is service-oriented, including tourism, with agriculture, natural resources and manufacturing providing some economic diversity. An analysis of the economic contributions of the CAP to Arizona, commissioned by the CAWCD examined the direct, indirect, and induced effects of the construction of the CAP as well as the economic contributions of

CAP's water delivery to the state's overall economic development (Seidman Institute 2014). Results of the statewide analysis included the following:

- CAP water deliveries represented approximately 30 percent of statewide M&I water deliveries and 11 percent of water used for agriculture between 2007 and 2009.
- Contributions to the statewide gross domestic product associated with those deliveries accounted for an estimated 32 percent of the total statewide gross domestic product during that same period.
- Had CAP water not been available during that period, and an equivalent amount of water not been available from another source, there would have been 1.09 million fewer jobs in the state.
- The estimated economic contributions associated with the CAP water deliveries increased by nearly 50 percent in 2010, but a basis for the dramatic increase was not reported.

The analysis did not prepare estimates of CAP-related economic contributions for individual counties or for the CAP-related tribes. Neither did the study address the relationship between CAP construction and subsequent water availability to population growth, although as noted above, the population of the three metropolitan counties in central Arizona more than doubled growth between 1985 and 2010.

3.18.3.3.1.1 Agriculture

As previously noted, the initial vision for the CAP was primarily to provide irrigation water for agriculture in central and southern Arizona. Major scale urbanization and conversion of land use has occurred in the years since CAP was built; resulting in reallocation of water use. As a result, the economic contributions from agriculture have been surpassed by those from other industries, but agriculture remains an important economic element in the region. According to the 2012 U.S. Census of Agriculture, the most current available, a total of 4,272 farms encompassing nearly 4.3 million acres of land operated in Maricopa, Pima and Pinal counties (**Table 3.18-26**) (USDA, NASS 2014a). The farm operations in the three counties are generally more intensively used and more productive than those in the remainder of the state. CAP water serves an important role supporting the irrigated lands, although groundwater and water from other surface sources also are used. Farms in the 3-county area sold more than $2.0 billion in crops, livestock and other agricultural products in 2012, producing $272.9 million in net income.

Table 3.18-26 Selected Characteristics of Agriculture in Arizona, 2012

	3-County Region	Arizona	Regional Share of the State Totals
Total Number of Farms	4,272	20,005	21%
Land in Farms (acres)	4,262,644	26,249,195	16%
Value of products sold	$2,028,499,000	$3,732,113,000	54%
Net cash farm income from operations	$272,932,000	$600,395,000	45%

Source: USDA, NASS 2014a.

Agriculture is an important economic undertaking for the Ak-Chin, Gila River Indian Community, and the Tohono O'odham Nation these three tribes receive direct deliveries of CAP water. Among these three tribes were roughly 110 farms having a total of 50,580 irrigated acres involved in farming operations. (**Table 3.18-27**). Barley, corn, cotton, melons, nuts, potatoes and livestock forage were the primary crops raised on the farms on tribal lands. Fort McDowell Yavapai Apache and the Salt River Pima-Maricopa

Indian Community also conduct significant farming operations but they do not currently utilize CAP water in those operations, allowing them to direct their CAP allocations for other purposes.[18]

Table 3.18-27 Selected Characteristics of Farming on CAP-affected Reservations in Central Arizona, 2012

Reservation	Number of Farms	Irrigated Lands (acres)	Total Market Value of Sales (2012)	Primary Crops Harvested
Ak-Chin	4	15,000 (est)	Not reported	Not reported
Fort McDowell Yavapai	9	2,000 (est)	Not reported	Barley, Corn, Cotton, Pecans
Gila River Indian Community	41	27,152	Not reported	Barley, Forage
Salt River Pima-Maricopa	15	27,056	$72,538,000	Wheat, Barley, Cotton, Corn
Tohono O'odham Nation	64	8,428	$10,153,000	Barley, Cotton, Corn, Melons

Source: USDA, NASS 2014b.

Total market values of sales and the net income of farming operations of the 5 tribes were not disclosed in the 2012 Census.

3.18.3.3.1.2 Central Arizona Water Conservation District Operations and Finances Related to the Navajo Generating Station

The CAP uses about 3,000,000 megawatt hours of energy (MW hours) annually to lift, transport and deliver about 1.6 million acre-feet of water from the Colorado River to central Arizona. The net elevation change along the aqueduct is about 1,900 feet. However, because the water flows down gradient between each of the 14 pumping plants, the CAP pumps operate 'around the clock' providing total lift of approximately 3,000 feet. The continuous operations mean that much of CAP's energy portfolio must be provided by baseload resources that are available 24 hours a day. Currently, NGS fills that requirement, supplying approximately 90 percent of the CAP system's total power demand (CAWCD 2015b).

NGS power used for CAP pumps represents about 64 percent of the U.S.' share of NGS power; the remainder is available to be marketed to generate revenues for the Lower Colorado River Basin Development Fund (Development Fund). Revenues accruing to the Development Fund are used to pay certain fixed O&M funds attached to the water allocations for tribes and the CAWCD's repayment obligation to the federal government. The linkages between the availability of excess power, surplus revenues, the repayment obligation, and energy costs are a source of substantial concern for the CAWCD and its tribal and non-tribal customers.

CAP pumping and water deliveries occur year-round to support M&I deliveries. Agricultural and higher M&I deliveries occur during spring and summer. In 2014, CAP water deliveries of 1,525,960 acre-feet of water were made to 77 customers, 50 of which were M&I customers and 16 of which received water deliveries from Indian water allocations.[19] [20] Total deliveries for M&I use accounted for 39 percent of the total deliveries, those deliveries serving about 50 percent of the municipal water supply in the three

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[18] The remaining tribes either do not engage in farming, or did not participate in the 2012 Census of Agriculture.

[19] An acre-foot of water equals approximately 326,000 gallons, enough to serve the average annual demand of 3 homes in the CAP service area.

[20] The 16 customers receiving water from Indian allocations include non-tribal entities that have leased water from one of the tribes.

counties (CAWCD 2014). Water deliveries allocated to CAP-affected tribes accounted for 35 percent of the 2014 water deliveries. Non-tribal agricultural deliveries, which are contingent upon the availability of sufficient quantities of water, and water used in CAP's recharge program accounted for the remaining 26 percent of deliveries. The recharge program stores water underground for future withdrawal during periods of reduced supplies (CAWCD 2015b). Over time, the availability of excess water for non-tribal agricultural deliveries is anticipated to decline as future population growth results in higher M&I use. **Table 3.18-28** summarizes CAWCD's customer base, water deliveries, and water delivery revenues for calendar year 2014.

Table 3.18-28 CAWCD Water Deliveries and Net Water Delivery Charges, 2014

Customer Category	Number of Customers	Quantity Delivered - acre-feet (Range)	Total Quantity Delivered - acre-feet	Net Water Delivery Charges Generated
Municipal and Industrial	50	3 to 142,315	503,518	$ 71,167,812
Federal and Indian	16 [1]	178 to 254,126	534,281	75,828,463
Agricultural Settlement Pool [2]	17	66 to 126,978	400,741	20,071,993
Recharge Program	8	1,230 to 54,839	87,420	8,806,506
Total	77 [3]	3 to 254,126	1,525,960	$ 188,290,754

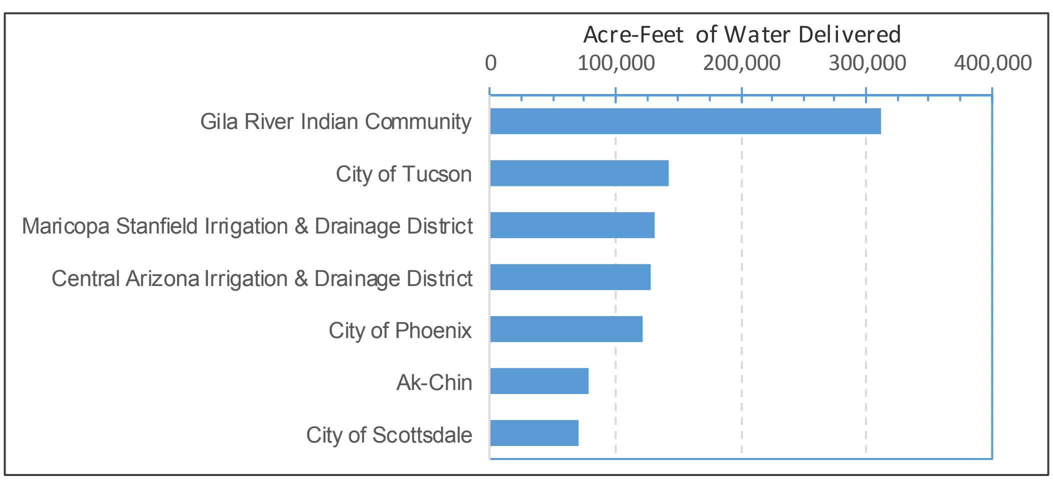
[1] Includes non-tribal entities that have leased water from tribes with CAP allocations.

[2] The agricultural settlement pool refers to a group of agricultural customers who agreed to relinquish water rights in exchange for water deliveries via the CAP, those deliveries to be billed at the cost to CAWCD of pumping energy only. The pool is currently 400,000 acre-feet per year, decreasing to 300,000 acre-feet per year in 2017, 225,000 acre-feet per year in 2024 and 0 in 2031 (CAP 2015).

[3] Total accounts for customers that receive water under more than one category.

Source: CAWCD 2015b.

The seven largest customers, in terms of water deliveries in 2014, are shown in **Figure 3.18-6**. The combined water delivery to these customers was over 928,000 acre-feet, approximately 61 percent of the total deliveries. Two of the seven are Indian tribes, including the Gila River Indian Community which took delivery of 254,126 acre-feet of water.



Source: CAWCD 2015b.

Figure 3.18-6 Customers with Highest CAWCD Water Deliveries, 2014

Expenses to operate and maintain the CAP system in 2014 totaled $253.8 million. Of that total, $227.4 million was operating expenses and $26.4 million was non-operating expenses. The latter is primarily comprised of the interest portion of CAWCD's federal debt repayment obligation.

Together, pumping power and salaries and related labor costs account for the majority of annual operating costs (**Figure 3.18-7**). The CAWCD has a staff of approximately 470 employees who are collectively responsible for the O&M of the CAP.

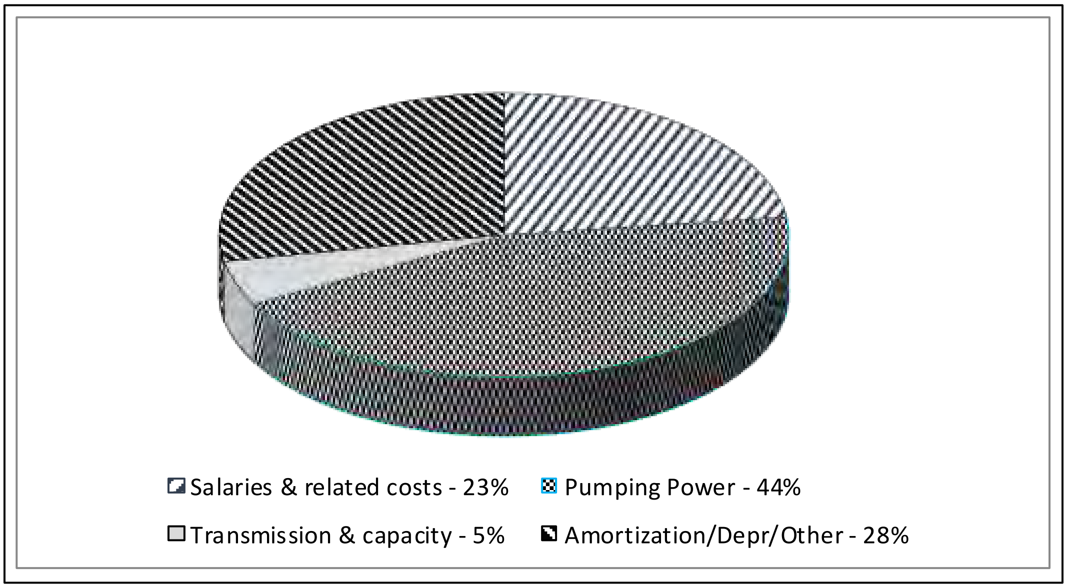


Figure 3.18-7 CAWCD Operating Expenses by Major Category, 2014

In addition to funding the annual O&M expenditures, CAWCD's liabilities include its contractual repayment obligation to the U.S. The repayment agreement requires annual payments over a 50-year period, commencing in 1993 with a final payment due in 2045. In 2007, through a Stipulated Settlement, the CAWCD and the U.S. established the principal amount of CAWCD's repayment obligation for the CAP system and storage facilities at $1,646,462,500 in conjunction with delivery of 667,724 acre-feet for federal use. This Settlement also provided that future net miscellaneous revenues and net revenues from surplus power sales, which accumulate in the Development Fund, will be credited annually against the repayment obligation due from CAWCD. The CAWCD's annual repayment obligation in 2014 was $57.8 million. At the end of 2014 the remaining balance on the repayment obligation was approximately $1,203,793,000. Average annual payments for the period 2014 to 2019 are $56,340,800.

CAWCD's total budgeted revenues for 2014 were $339.26 million (**Table 3.18-29**). Water delivery charges, reimbursements, other revenues, and to the extent needed, property taxes and interest income are used to pay operating costs associated with delivering water and capital expenditures. Water and energy revenues and property taxes, the two largest categories of revenues, are anticipated to provide 75 percent of all revenues. Development Fund surpluses, which are credited to the CAWCD as revenues to be applied to its repayment obligation to the federal treasury, are projected at $34.4 million.

Table 3.18-29 CAWCD Budgeted Revenues, 2014

Source of Revenue	2014 Budgeted Revenues	Percent of Total
Water and energy revenues	$190,444,000	56.1
Water service capital charges	$14,858,000	4.4
Development fund revenues	$34,435,000	10.1
Reimbursements and other	$28,835,000	8.5
Property taxes	$63,984,000	18.9
Interest Income and other	$6,708,000	2.0
Total Budgeted Revenues	$339,264,000	100.0

Source: CAWCD 2015b.

Water rates are set to generate necessary revenues to meet operating expenses, debt service and capital expenses. Water delivery rates vary by category of customer and are set on a per acre-foot basis, with the total rates for a customer comprised of as many as three components: a fixed O&M charge, charge to cover costs of pumping energy, and capital charges. These charges are described below.

Fixed O&M charges are non-energy costs associated with ongoing system operation. All customers, other than those in the agricultural settlement pool, are assessed O&M. Energy transmission and distribution charges incurred by CAWCD are included as part of the O&M. The O&M charges also include a rate stabilization component – essentially a credit used to protect customers from mid-season rate adjustments if the price of energy fluctuates outside the expected range. Excess credits are applied to the following year's charges. For M&I subcontractors, the charge is applied to each contractor's delivery volumes and include a take or pay provision. The U.S. pays the O&M on behalf of some Indian tribes and funds available from the sale of excess energy may be used to pay these charges. The O&M charge for 2014 was $79 per acre-foot.

Energy charges include the cost of energy delivered to the CAP system to pump water from the Colorado River through the CAP system. All customers pay energy charges. The 2014 energy charge was $67 per acre-foot and included a rate stabilization component – essentially a credit used to protect customers from mid-season rate adjustments if the price of energy fluctuates outside the expected range. Excess credits are applied to the following year's charges.

Capital charges are assessed on non-tribal customers that do not have fixed annual entitlements (e.g., contractors who purchase excess water). Capital charge revenues are used to amortize project capital charges. Indian contractors of CAP water do not pay water service capital charges because the capital charges associated with their water deliveries are not included in the reimbursable costs to be paid by CAWCD. The capital charge for 2014 was $20 per acre-foot.

Table 3.18-30 below shows the overall rates by customer category, and the composition of the rates. The rates for 2014 deliveries ranged between $67 and $166 per acre-foot.

In 2014, 43 percent of CAWCD's total water and energy revenues in 2014 were derived from deliveries of allocations to Indian tribes, parties that have leased water from a tribe, or other allocations to the federal government. As an individual category, M&I customers accounted for 41 percent of the total water and energy revenues. The agricultural settlement pool and excess water customers accounted for 16 percent of the total water and energy revenues (**Figure 3.18-8**).

The CAWCD is authorized to levy two ad valorem taxes on all taxable property within its boundaries. The first, not to exceed $0.10 per $100 of assessed valuation, can be used to fund CAWCD's operations and payment of its repayment obligation to the U.S. The second, not to exceed $0.04 per $100 of assessed valuation can support operations, repayment, or be used to provide for water storage. In 2014, CAWCD levied both taxes at their maximum permissible rate. Together the two taxes yielded $63.98 million.

Table 3.18-30 CAP 2014 Rates Per Acre-Foot of Delivered Water

Rate Component	Customer Category: Municipal and Industrial Long-term Subcontract	Excess Water (non-subcontract) [1]	Federal / Indian	Agricultural Settlement Pool	Recharge
Fixed O&M	$79	$79	$79	NA	$79
Pumping Energy	$67	$67	$67	$67	$67
Capital Charges	NA	$20	NA	NA	$20
Total	$146	$166	$146	$67	$166

[1] Excess water (non-subcontract) customers are those with options to take delivery of water that can become available when the amount of water exceeds contracted deliveries under long-term contracts and subcontracts.

NA = not applicable.

Source: CAWCD 2015b.

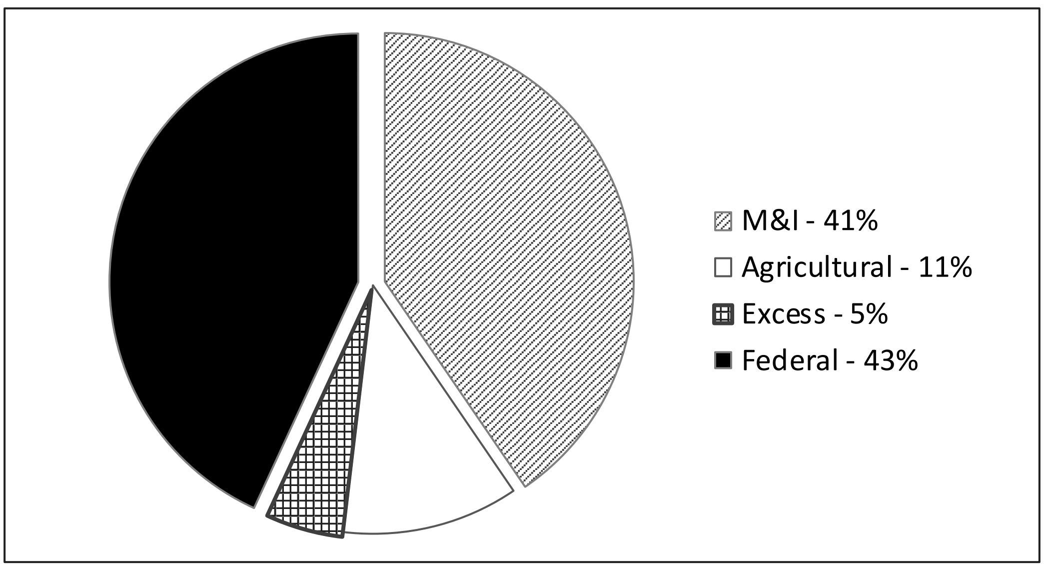


Figure 3.18-8 Water and Energy Delivery Revenue by Major CAWCD Customer Category, 2014

3.18.3.3.1.3 Lower Colorado River Basin Development Fund

The Lower Colorado River Basin Development Fund (Development Fund) is a separate fund within the U.S. Treasury established by Congress in the Colorado River Basin Project Act, which authorized construction of the CAP. Revenues deposited into the Development Fund include the sale of power from NGS that is surplus to CAP pumping needs; a surcharge on power sold in Arizona from Hoover Dam and the Parker and Davis Dams; and other miscellaneous revenues from CAP operation (43 United States Code § 1543).

The Arizona Water Settlements Act allows the Development Fund to be available to fund the Gila River Indian Community Water Rights Settlement, the Southern Arizona Water Rights Settlement and future Indian water rights settlements in Arizona. By law and contract, those funds are credited each year against CAWCD's repayment obligation for the CAP. After the money in the Development Fund has been credited against CAWCD's repayment obligation, those funds may be used, without further appropriation, by Reclamation, which administers the Development Fund, for other specific purposes defined in the Act.

Any funds not used in the year they become available are carried over to the following fiscal year and are again available for the purposes outlined above. Under the Arizona Water Settlements Act, Development Fund revenues not needed to meet current requirements may be invested and the interest income used for the same purposes.

3.18.3.3.2 Sociocultural Conditions

As outlined above, CAP is economically important to Arizona, its largest population centers and a large portion of its agricultural sector. The availability of CAP water, while not the driving factor for the economic and population growth experienced in the Phoenix and Tucson areas in recent decades, was an important enabling factor. Moreover, the availability of a reliable water supply is a key contributor to the economic vitality and quality of life enjoyed by people in the communities and reservations served by the CAP, which is over 80 percent of the population in the state (CAWCD 2014). A study of the CAP's economic contributions estimated that the CAP contributed to almost half of Arizona's gross state product in 2010 (Seidman Institute 2014).

The CAP water serves important cultural, social and economic functions for the tribes that receive water from Indian water rights, which were secured through water rights settlements and secretarial decisions allocating water to tribes. Prior to European settlement, water supported hunting, fishing, gathering, agriculture and cultural ceremonies on lands occupied and used by the CAP-affected tribes. In several cases these tribes had elaborate and sophisticated irrigation systems. As reservations were established, and European settlers diverted waters that formerly fed rivers and streams that flowed through and near some reservations, water was no longer available to sustain the traditional uses for many of these tribes (Gila River Indian Community n.d.; Lewis and Hestand 2006; Pueblo of Zuni 1999; Tohono O'odham Nation 2014; Waldman 2006). In some cases, the lack of water on reservations resulted in economic dependency, malnutrition and disease (Gila River Indian Community n.d.; Lewis and Hestand 2006).

Most American Indian water rights are determined under the *Winters* Doctrine which arose out of the 1908 federal case, *Winters v. United States*, in which the Court held that when Congress set aside lands for a reservation, it implicitly reserved sufficient water to fulfill the purposes of the reservation. Historically, the purpose of most reservations was designated as agricultural, and tribes were granted rights to the amount of water necessary to irrigate all land on the reservation that could feasibly and economically be irrigated. In 2001, the Arizona Supreme Court concluded that Indian reservations were established as homelands, and the court articulated a homeland standard for the measure of reserved water rights based on tribal economic development plans, cultural needs, and historic water uses (Cosens 2002).

As noted above, CAP-affected tribes use their CAP water for agricultural, residential, commercial, industrial, recreational, and cultural purposes, and some tribes lease their water rights to other users as a means of generating revenues to support tribal government and programs. CAP-affected tribes also have plans to support future agricultural and development uses and population growth, to accomplish their economic development and tribal self-determination goals. Some tribes feel that water rights settlements and the availability of CAP water at affordable rates will allow reestablishment of traditional irrigation-based agriculture on their reservations (Gila River Indian Community n.d., 2014; NREL 2012a).

Concerns of CAP-affected tribes concerns about the Proposed Action and Alternatives mainly are focused on the cost of water, but water cost has important social and cultural implications as well. For example revenues gained from the various uses of CAP water currently are used to fund tribal services and for some tribes, increases in the cost of delivery of CAP water affect their ability to provide other services to tribal members (Yucupicio 2014). CAP-affected tribes are concerned that changes to the NGS would make CAP water uneconomical for some uses, thereby calling into question some of the assumptions that informed past and future water rights settlements (CAWCD 2014).

3.18.3.3.3 Factors that may Contribute to Socioeconomic Change through 2019

3.18.3.3.3.1 Prospect of Stage I Water Shortages on the Colorado River

Continuing drought in the southwestern U.S., combined with below average precipitation and run-off in the upper Colorado River basin have resulted in declining water storage volumes in Lake Powell and Lake Mead, and reduced water flows in the Colorado River basin. Under an agreement between the lower basin states and the Department of the Interior, the Secretary will declare a shortage if the water elevation in Lake Mead falls below certain levels, subsequently reducing the amount of water that each lower basin state can withdraw. The first trigger, termed Stage I, is at a pool elevation 1,075 feet at which point Arizona's deliveries would be reduced by 320,000 acre-feet per year. Additional shortage triggers are at pool elevations 1,050 feet (Stage II) and 1,025 feet (Stage III), with corresponding reductions of 400,000 and 480,000 acre-feet for annual Arizona water deliveries. Absent substantial conservation, increased water runoff, or cooler temperatures, the Department of the Interior has advised the lower basin states that a Stage I shortage could be declared for 2017. In the event of shortage, water deliveries are reduced in order of priority. In a Stage 1 shortage, deliveries of excess water and the agricultural settlement pool are reduced while tribal and municipal pool are reduced while tribal and M&I priorities are not affected. CAP's pumping energy requirements and associated energy and transmission costs would decline, increasing the availability of excess energy for sale to generate surplus revenue.

3.18.3.3.3.2 Changes in Central Arizona Water Conservation District Water Delivery Rates

CAWCD has established rates for water deliveries in 2016 that include a $6 per acre-foot increase in fixed O&M cost and $9 per acre-foot increase in energy costs for its M&I and Federal-Indian customers, as compared to the comparable rates in 2014. The combined increases represent a 10.2 percent increase. Capital charges paid by some customers will increase by an additional $3 per acre-foot. **Figure 3.18-9** shows the 2016 rates, by major component, along with current, recent and forward-looking advisory rates through 2020.

CAWCD prepares forward-looking advisory rates as part of its financial budgeting process. The advisory rates reflect foreseeable changes in energy, operating, and maintenance costs. CAWCD provides these rates to its customers for use in their long-term financial planning programs. The current advisory guidance for 2019 per acre-foot delivery rates for M&I and Federal-Indian customers in 2019 are $178 per acre-foot, a 22 percent increase over the $146 per acre-foot in 2014 (**Table 3.18-31**) (CAWCD 2015).

According to CAWCD, declaration of shortage on the lower Colorado River would reduce the delivery volumes and require rate increases to cover the fixed O&M.

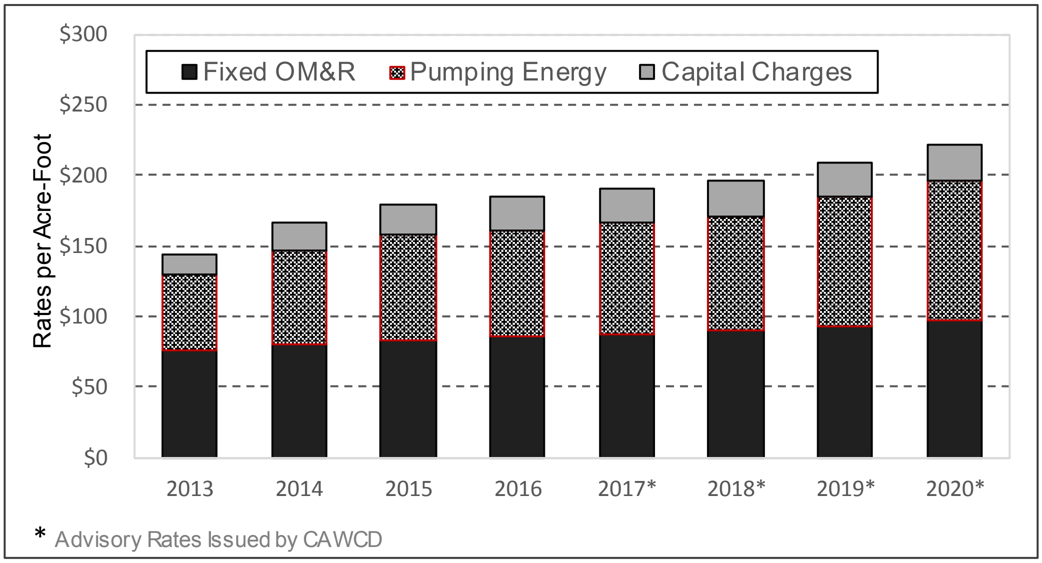


Figure 3.18-9 CAWCD Firm and Advisory Water Delivery Rates, 2014 to 2020

3.18.3.3.3.3 Projected Population Growth in the Area of Indirect Effects

Long-term population forecasts prepared by the state reflect an outlook for continued strong regional growth through the period of historical operations, through 2019. Under the medium growth series, the combined population for Maricopa, Pinal and Pima counties, that together encompass the Phoenix and Tucson metropolitan areas, would increase to 6,100,100 by 2020, a gain of more 910,000 over the total in 2010. Of the 6.1 million projected residents in the region, more than 4.5 million would reside in Maricopa County (**Table 3.18-31**). Under the high series, the combined population of the three counties would rise to 6,297,000, approximately a 17 percent increase in a decade and equaling the growth experienced during the decade 1990 to 2000.

Table 3.18-31 Population Forecasts for Central and Southern Arizona, 2010 to 2020

	2010	2020	Chg. 2010 – 2020	Total Change (percent)
Maricopa County	3,824,100	4,506,900	682,800	18
Pinal County	376,400	493,200	116,800	31
Pima County	981,200	1,100,000	118,800	12
Regional Total	5,181,700	6,100,100	918,400	18

Source: Arizona Department of Administration 2012a.

3.18.3.3.3.4 Land Use Conversion Associated with Growth

Population and economic growth in central Arizona has triggered major conversion of land from rural undeveloped and agricultural use. An example of such conversion is provided by data from the U.S. Census of Agriculture indicating a net reduction of more than 700,000 acres of farmland in Maricopa, Pinal and Pima counties between 1997 and 2012, a period of strong population growth and urbanization in the Phoenix and Tucson metropolitan areas. Such conversion and development will likely continue through the end of 2019. Some changes in water use, including conversion from agriculture to M&I, also may occur, but the changes would not be expected to fundamentally change socioeconomic conditions in central Arizona.

3.18.4 Environmental Consequences

3.18.4.1 Issues

- Impacts of power plant and mine operations on regional employment and wages, particularly as related to the Navajo and Hopi tribes.
- Impacts on demographic, economic, attitudes, and social organization trends on Navajo and Hopi populations.
- Impacts of the current and future financial contributions of coal mining and electrical generation (royalties, permit and lease fees, payments to communities) to the Navajo Nation and Hopi Tribe.
- Impacts to the social fabric and values that provide incentives for younger tribal members to remain on the Reservation.
- Impacts of current and future costs of power required for CAP pumps. Economic impacts if there are reductions in surplus revenues for the Development Fund, and to fund Indian water settlements.
- Impacts related to the social cost of carbon. This issue is addressed in accordance with current federal guidance in Section 3.2, Climate and Climate Change.

3.18.4.2 Assumptions and Impact Methodology

- Implementation of a PFR Alternative presupposes concurrent operation of the NGS, proposed KMC, and continued use of the transmission lines and communications sites.
- The PFR Alternatives address only the federal share of NGS power and energy. No other changes in ownership, allocations of energy and power, or other characteristics of the NGS and other facilities are assumed in the EIS.
- Approval of the Proposed Action or action alternative would result in a series of future economic and social effects that are in large measure a continuation of similar effects that are associated with the existing operations.
- Non-federal participants continuing in NGS would continue to draw their full share of energy and power from NGS (i.e., they would not seek long-term curtailments of energy and power).
- In the event that a PFR Alternative is approved as part of the Record of Decision, the remaining participants in NGS would reach agreement allowing Reclamation to seek long-term curtailments of the federal share consistent with the specified PFR alternative. The terms of the agreement could specify the maximum allowable curtailment; (i.e., 100 megawatts [MW] to 250 MW). The impacts for intermediate values within that range would be proportional to those evaluated herein.
- To assess the potential effects of the Proposed Action, it is assumed that NGS would operate for the full 25-year period.
- The employment and income effects of the Proposed Action operations are estimated using a version of the IMPLAN model, calibrated for northeastern Arizona, in conjunction with employment and income information provided by SRP and PWCC. IMPLAN is a widely accepted commercial economic model. IMPLAN Group, the model's developer, prepares data

sets for every county and state in the nation, based on economic data from the U.S. Bureaus of Economic Analysis, Labor Statistics, and the Census.

- Economic impacts for the PFR alternatives are scaled from those associated with the Proposed Action operations, based on changes in energy production, annual coal production and changes in direct employment. Estimates of the latter were provided for the two Proposed Action operations by SRP and PWCC.
- The future costs of pumping energy for the CAP are estimated using projections of the base costs of NGS energy, the incremental costs that would be incurred at NGS after 2019, assuming operations would continue, and the projected costs of energy from lower-emitting alternative sources. **Technical Supplement 3.18-A**, located at the end of this section, describes the methodology and results of the analysis. The key results for each alternative are reported in the body of this section.
- Effects on sociocultural conditions were assessed based on the review of 1) historic and current sociocultural trends, 2) scoping comments and an analysis of community input from Kayenta and former Black Mesa mine area resident listening sessions, and 3) published journal articles, print media articles, and affected interest group websites. Interviews were conducted with tribal officials, Kayenta and former Black Mesa mine area residents, and off-reservation local government officials to further explore sociocultural conditions, trends and potential effects from the Proposed Action and alternatives.
- The socioeconomic effects of the PFR alternatives would be the combined effects attributable to Proposed Action and the incremental changes in effects of the specific PFR alternative.
- From an operational perspective, output at NGS would be curtailed under the PFR alternatives, (i.e., scaled back), to lower output by the amount of energy corresponding to that supplied by the replacement source. Section 2.2.3.2 and **Appendix 2A** for additional detail regarding the assumed operation and energy output of the PFRs.[21] Curtailing output at NGS would reduce the amount of coal combusted, direct labor requirements, and certain revenues paid by NGS and PWCC to the tribes and local governments.
- The generating sources for replacement power that would be purchased under the Natural Gas and Renewable PFR alternatives are assumed in existence in 2020. Temporary effects associated with construction of a new photovoltaic solar facility on tribal land are assumed to occur in 2023 and 2024 such that the new capacity is operational in 2025.
- The 100-MW and 250-MW increments of energy delivery are used as the basis for assessing the differences in effects that could result under the PFRs. Those increments should not be considered as discrete options, but rather as lower and upper limits of the reasonable range within which the actual project capacity and quantity of replacement energy and power for a PFR Alternative would be defined in the future. (Section 2.2.3.2 and **Appendix 2A** provide additional details regarding the energy delivery characteristics of the PFs.)
- Differences in effects associated with a specific partial replacement alternative are compared to those for the corresponding configuration of the Proposed Action; i.e., the incremental changes associated with the Natural Gas 250-MW PFR are based on the Proposed Action 3-Unit Operation. Differences between the socioeconomic effects of the Proposed Action 3-Unit Operation and 2-Unit Operation are addressed separately under the Proposed Action.

[21] Under existing arrangements with the NGS Co-tenants (SRP, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company), Reclamation is able to curtail 100 MW. Curtailments exceeding 100 MW would require additional technical, engineering, and cost studies to determine the impact on plant operations, efficiencies, and maintenance. It is anticipated that due to cost and generation implications, additional agreements among the NGS Co-tenants and Reclamation would be necessary prior to curtailments above 100 MW.

- Summary findings of the socioeconomic impacts are presented for each alternative. The findings include a qualitative descriptor that considers magnitude, duration, intensity, and context. A brief statement of the rationale for the finding also is presented. The qualitative descriptors for socioeconomics are described below.
  - *Negligible*: Impacts to local and regional economic and social conditions, including employment opportunity, personal income, community and social stability, and tribal fiscal status would be at or below the levels of perception or detectable only through indirect means.
  - *Minor*: Impacts to local and regional economic and social conditions, including employment opportunity, personal income, community and social stability, and tribal fiscal status would be detectable but would not be outside the typical range of variability. The impact could be short-term or infrequent, of higher intensity, geographically localized, and affect few residents and governmental institutions, or for a longer period of time but of lower intensity, and affecting a broader population.
  - *Moderate:* Impacts to local and regional economic and social conditions, including employment opportunity, personal income, community and social stability, and tribal fiscal status would be readily apparent or observable across a wider geographic area, affect many residents and governmental institutions, and could have noticeable effects on the established economic or social conditions over the long term, or the impacts could be substantial but of a short duration with no permanent impacts to social and economic conditions. It is anticipated that mitigation, if implemented, would be successful with a high degree of certainty, based on prior examples with similar effects, and documented mitigation outcomes.
  - *Major:* Impacts to regional economic and social conditions, including employment opportunity, personal income, community and social stability, and tribal fiscal status would be readily apparent or observable across a wider geographic area, affect many residents and governmental institutions, and would result in substantial impacts to the resource. Mitigation, if implemented, would be uncertain in its success, or ineffective with consequent long-term and permanent changes in the availability or natural recovery of the resource.

3.18.4.3 Proposed Action

3.18.4.3.1 Navajo Generating Station

Approval of the Proposed Action would allow the NGS to continue operating from 2020 through 2044. Future operations would be consistent with historical operations including the use of coal supplied by the proposed KMC and transported by the BM&LP Railroad, use of water from Lake Powell for cooling, ash disposal in the on-site landfill or offered for sale for off-site use, and periodic overhauls.

Approval and implementation of the Proposed Action would trigger three key changes that would alter socioeconomic effects associated with the NGS plant as compared to those that would characterize the period of historical operations, through 2019. Those changes include:

The provisions of Lease Amendment No. 1 between the Navajo Nation and NGS Co-tenants (or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1) would become effective;

- Changes in work force, scheduling of overhauls, scheduling of power deliveries and other operating parameters would occur should the 2-Unit Operation be implemented; and
- Selective Catalytic Reduction installation on 2 or 3 units for operation beyond 2030.

In addition to the continuation of ongoing programs and benefits, the connections between these changes and future socioeconomic consequences are described below.

Amendment #1 to the Indenture of Lease (Lease Amendment No.1): Under the terms of this amendment (or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1), the Navajo Nation would realize substantial increases in payments from the NGS participants from those received under the 1969 Lease. The additional revenues consist of: 1) increases the annual lease payments for the 323 ROW grant to $9,000,000, 2) an additional payment of $34,000,000 per year; 3) increases the support for scholarships to approximately $250,000 per year; 4) an annual community payment of approximately $180,000; and, 5) a one-time payment for timely execution of the agreement. The first four of these elements would be subject to escalation based on the Consumer Price Index. For 3-Unit Operation the changes would yield a 1,400 percent increase in payments to the Navajo Nation over the 1969 Lease. Under 2-Unit Operation, the net increase would be nearly 1,000 percent because the additional payments would be scaled back to $22.7 million based on a rated capacity of 1,500 MW for the two remaining operational generating units. The $9,000,000 base lease, scholarship support and community payments would be unaffected.

Lease Amendment No. 1 (or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1) affords the Navajo Nation an option to acquire an ownership interest in the NGS. However, the potential socioeconomic implications of this action are not addressed in this section because the timing, costs and other contractual and fiscal arrangements involved with exercise of that option are uncertain.

The Hopi Tribe is not a party to the NGS lease and therefore would not be directly affected by the terms of Lease Amendment No. 1.

Operation of NGS in a 2-Unit Operation: Retiring one of NGS's existing generating units would scale back the facility's work force requirements, quantity of coal purchased and used, frequency of coal deliveries, eliminate the need for a minor and a major overhaul in each 6-year cycle, lower the plant's valuation for property tax purposes, and reduce the coal royalties paid to the Navajo Nation and Hopi Tribe, among other effects. Each of these changes would have socioeconomic effects, often indirect. The analysis focuses on socioeconomic parameters likely to be affected by the continuation of existing programs and benefits together with any future changes in operations at NGS to differentiate the socioeconomic effects of alternatives.

Under a 2-Unit Operation, the federal share of NGS power would be 540 MW, 7 MW less than under the 3-Unit Operation. The reduction would have relatively little effect on Reclamation's operations as they relate to the availability of power to supply CAP's energy needs and as surplus for sale. However, Reclamation's share of power during overhauls would be approximately 270 MW, less than CAP's baseload requirement. The shortfall could be addressed by obtaining power from other sources. The shortfall also would limit the availability of surplus energy during that period.

Future installation of selective catalytic reduction on the operating units: Operation of the NGS beyond 2030 would ultimately lead to a need to install selective catalytic reduction to meet air quality standards. The approximate cost of such installation was estimated at $554 million to $1.23 billion if installed on all 3 units (NREL 2012a). Installation costs of $796 million are assumed for purposes of the energy rate cost analysis (see **Technical Supplement 3.18-A**). Installation would involve a temporary influx of workers and associated economic boost in the local economy, perhaps a few additional full-time workers on staff at NGS, and increase the facility's tax valuation for property tax purposes.

The initial changes in payments to the Navajo Nation associated with Lease Amendment No. 1 and the 2-Unit Operation may occur relatively quickly, but the full implications of those payments could take time to manifest themselves in the regional economic and community setting. Under the Proposed Action, installation of selective catalytic reduction equipment to meet air quality emissions standards is envisioned as being necessary between 2022 and 2027 under the 3-Unit Operation and between 2026 and 2029 for the 2-Unit Operation in order for operations to continue beyond 2030. Implementation of a PFR Alternative could affect the timing of selective catalytic reduction installation due to the effects of curtailment in reducing future NO_X emissions. However, the extent and timing of such effects are dependent upon site specific information that is not available now and would be analyzed in future NEPA if the Tribal PFR Alternative is selected.

Selected socioeconomic parameters associated with continued operation of NGS under either a 3-Unit Operation or 2-Unit Operation are shown in **Tables 3.18-32**, **3.18-33,** and **3.18-34**. Operation of the BM&LP Railroad, using the existing rail line, loadout, unloading and storage yards would continue in use under either Proposed Action operation. In some instances the parameters shown are indicative of the initial change, but also a measure of the cause of subsequent socioeconomic effects. For example, the direct employment at NGS under the 3-Unit Proposed Action operation, 521 workers, is shown in **Table 3.18-32**, as is the corresponding direct work force of 398 for the 2-Unit Operation. The difference of 123 direct jobs represents the estimated reduction of NGS and on-site contractor jobs associated with retiring one unit.

Decommissioning would provide temporary support for an unspecified number of additional direct and secondary jobs for several years following final shutdown when the plant is taken off-line (see **Appendix 1B**). Also shown in the tables are the total number of jobs, including jobs supported through indirect and induced spending and the estimated tribal employment that could be supported by the payments to be made by the NGS participants; a total of 1,643 additional jobs under the 3-Unit Proposed Action operation and 1,218 additional jobs for the 2-Unit Proposed Action operation.

Implementation of the Proposed Action under the 2-Unit Operation would generally result in many of the same socioeconomic effects associated with the Proposed Action under the 3-Unit Operation, but at scaled back or reduced levels. In some instances the scaled back parameters cause changes that vary markedly from those under the 3-Unit Operation; for example, Proposed Action 3-Unit Operation sustains the current population in Page and nearby Navajo Chapters, while Proposed Action 2-Unit Operation would support fewer jobs and potentially promote population emigration from the region.

3.18.4.3.1.1 Operations and Employment

Table 3.18-32 focuses on operational and employment measures associated with the Proposed Action. The more noteworthy effects of the two operations are described following each table.

Approval and implementation of the Proposed Action 3-Unit Operation, with selective catalytic reduction installed would sustain the facility's role as a major economic element in the northeastern Arizona economy, continuing to provide energy and power to supply CAP and other electrical energy needs in Arizona. The federal amount and share of the power from NGS would remain at present levels under Proposed Action 3-Unit Operation.

Ongoing O&M of NGS would support an estimated 2,164 jobs in the regional economy, but excludes employment at the proposed KMC, which is addressed in a subsequent section. Over the 25-year period of extended operations, those jobs would represent 54,100 job-years of employment. The majority of that employment would represent continuation of existing jobs in the region that would be lost if NGS operations cease.

Table 3.18-32 NGS Operational and Employment Impacts of the Proposed Action

Parameter	3-Unit Operation (Total 2,250 MW, Federal: 547 MW)	2-Unit Operation (Total: 1,500 MW, Federal: 540 MW)
Operational		
Annual NGS Energy Production	17.34 TW hours	11.50 TW hours
Federal share of energy	4.17 TW hours	4.12 TW hours
Energy allocated to CAP	2.70 TW hours	2.70 TW hours
Energy available for Sale as Surplus	1.47 TW hours	1.42 TW hours
NGS-related Employment		
Operating and Maintenance		
NGS direct (plant and BM&LP Railroad)	521	398
On-site contractors (year-round)	38	33
Overhaul contractors (annual equivalent)	124	87
Tribal jobs	253	187
Indirect/induced jobs [1]	1,228	911
Total jobs	2,164	1,616
Temporary/Construction		
Overhauls Number of employees: Duration of activity Frequency of overhauls Yearly equivalent jobs [2]	~800 to ~1,200 ~4 wks. to 8 wks. per year Annually, alternating between minor and major 161	~800 to ~1,200 ~4 wks. to 8 wks. per year Four of every 6 years, alternating between minor and major 107
Selective catalytic reduction installation Number of employees: Duration of activity	Range: 13 to 494, ave. 240 Approx. 6 years. total, 4 years. of higher construction activity	Range: 100 to 421, ave. 253 Approx. 5 years. total, 3 years. higher construction activity
Decommissioning	Unknown number of jobs, for several years after closure.	Unknown number of jobs for several years.
Total job-years (2020 to 2044)	54,100, plus decommissioning	40,400, plus decommissioning

[1] Estimates of the indirect and induced jobs derived using an IMPLAN calibrated for northeastern Arizona.

[2] Reflects the average annual full-time equivalent jobs, including indirect and induced, over the 6-year schedule.

Under the Proposed Action 3-Unit Operation, BM&LP Railroad train operations would average about 21 round-trips per week. A capital investment program to replace locomotives, rolling stock, upgrade the catenary system, and improve the road bed would be implemented. Employment associated with the BM&LP Railroad would total 227 jobs; the same as current conditions. There would be no discernible changes in effects on population, housing, local retail and service establishments, or public facilities and services, as compared to existing conditions. Future BM&LP Railroad operations under the Proposed Action 2-Unit Operation would be approximately one-third lower than anticipated in conjunction with the Proposed Action 3-Unit Operation. Train operations would average about 14 round-trips per week, resulting in time-of-day or day-of-week schedule changes in comparison to the 3-Unit Operation. The lower frequency of train operations could ease any social concerns regarding safety at at-grade crossing.

The future employment totals include an allowance for more than 400 new jobs, or a comparable number of existing jobs that would otherwise be lost in the event of reductions in revenue from other sources, that could be directly and indirectly supported by the additional revenues received by the Navajo Nation under the terms of Lease Amendment No.1. Many, if not most, of any new tribal positions would be filled by Navajo. The geographic distribution of those jobs is uncertain; however, many would likely be located in those communities hosting tribal agency offices. Businesses in those same communities would see gains in consumer expenditures for goods and services. Businesses in off-reservation communities, including Flagstaff, Page, Gallup, Winslow, Holbrook and Farmington, among others, also would see changes in consumer spending.

In addition to the above would be short-term economic infusions associated with overhauls that would be scheduled to occur in 2017, 2018, and 2019, assuming Proposed Action 3-Unit Operation is implemented. Those overhauls may be scaled back or cancelled absent approval of the Proposed Action or action alternative. The job, income and local spending effects foregone due to such actions would be short-term but nonetheless important to the Page economy.

Implementation of the Proposed Action 2-Unit Operation with selective catalytic reduction installed, also would sustain the facility's role as an important economic element of the regional economy, but at a reduced scale as compared to operations under a Proposed Action 3-Unit Operation. Reclamation's share of NGS power under a 2-Unit Operation would be 540 MW (a -7 MW or -1.3 percent difference). As a result of the cutback in capacity, NGS power could supply CAP and other electrical energy needs, but the availability of excess energy for sale to support the Development Fund would be approximately 0.06 terawatt (TW) hours per year less (4 percent).

Ongoing O&M of the plant would support an estimated average of 1,616 jobs in the regional economy, the majority of which would represent the continuation of then-existing jobs. The total number of jobs would be 548 fewer (-25.3 percent) than under the 3-Unit Operation. The majority of those jobs would represent the continuation of then-existing jobs. Over the 25-year period of extended operations, those jobs would represent 40,400 job-years of employment in the regional economy, a difference of 13,700 job-years as compared to Proposed Action 3-Unit Operation. Achieving the cutbacks in NGS staffing from the levels anticipated at the end of 2019 would be effected through attrition, retirements, voluntary separations, transfers, and possibly lay-offs. The lower number of jobs under the Proposed Action 2-Unit Operation would contribute to lower economic support to maintain local population, housing demand, and consumer demand for local retail and service businesses. Local government could experience reduced revenues and demand for most services, although demand for some social services may increase temporarily.

Payments to the Navajo Nation for the 2-Unit Operation under Lease Amendment No.1 would be lower than under the 3-Unit Operation, but higher than those to be made in 2019 under the existing 1969 Lease. The future payments could support additional jobs that would offset some of the differences in NGS-related employment under the 2-Unit Operation.[22] However, there would likely be differences in geographic distribution between the jobs lost (more Page-centric) and jobs gained (Window Rock and Navajo Nation agency/service communities). Business in other off-reservation communities (i.e., Page and Gallup) also would see changes in consumer spending. The magnitudes of the changes and whether the net effects would be gains or losses are unclear.

3.18.4.3.1.2 Labor Income and Public Revenues

The changes in labor income and the annual payments to the tribes, local governments and local public education is another area of much public interest expressed during scoping. **Table 3.18-33** presents impacts on those socioeconomic indicators.

[22] The totals for Proposed Action 2-Unit Operation include an allowance for 187 jobs, based on the assumption that 70 percent of the revenues are devoted to support general fund employment and programs, the remainder allocated to capital programs and trust accounts. This allocation mirrors expenditure patterns in the Navajo Nation's 2014 general fund budget.

Under Proposed Action 3-Unit Operation, workers in the primary segment of the study area would realize a collective total of $149.7 million in labor income annually; a total of more than $3.7 billion over the 25-year period associated with Proposed Action 3-Unit Operation. The annual total is equivalent of 1.6 percent of the total personal income of the 3-county region in 2013. With the 2-Unit Operation, projected annual household income of $110.8 million would be generated in the study area. Wages and salaries paid in conjunction with the Tribal jobs and induced jobs supported indirectly by the payments to be made by the NGS participants to the Navajo Nation could account for a substantial portion of the total. The lease and additional payments associated with Lease would amount to an indirect monetary transfer from the electrical consumers, including CAP's water customers, to the Navajo Nation and its members.

Extending the operating life of NGS would generate future retirement income for more households, as presently occurs as a result of past operations of the NGS. Much of that future income would accrue to workers hired to fill positions as current workers retire. Payments of those benefits would extend beyond 2044. Similarly, any new tribal jobs supported by payments from NGS would accrue income benefits beyond 2044. Although the value of those benefits is not estimated, they would be important given persistent high unemployment and poverty among the Navajo.

Table 3.18-33 NGS Labor Income and Public Revenue Impacts of the Proposed Action

Parameter	3-Unit Operation	2-Unit Operation
Labor Income		
Annual (direct, indirect, and induced) [constant $, no escalation] [1]	$ 149.8 million	$ 110.8 million
Annual labor income as a percent of 3-county regional personal income	1.6%	1.2%
Total 2020 to 2044	$ 3,745 million	$ 2,770 million
Access to comprehensive benefit programs	Access to benefits extended for current and a future generation of workers.	Similar benefits to the 3-Unit Operation, but approximately 1/3 fewer beneficiaries.
Long-term pension and retirement income	Substantial income to many current and future workers	Similar effects as for the 3-Unit Operation, but fewer beneficiaries
Payments to the Navajo Nation, Local Governments, and Education Support		
NGS payments to the Navajo Nation		
Annual	$ 43 million	$ 31.7 million
Total 2020 to 2044	$ 1,075 million	$ 793 million
Property taxes paid by NGS participants to Coconino County/ Public Education: [2]		
Annual	$ 11.2 million	$ 7.7 million
Aggregate Total 2020 to 2044	$ 280 million	$ 193 million
NGS Scholarships, Community Support, and employee donations to charitable organizations and campaigns	>$430,000 / year (NGS) + unknown amount from employees	> $430,000 / year (NGS) + unknown amount from employees

[1] These totals include estimates of the indirect and induced income derived using an IMPLAN model calibrated for northeastern Arizona.

[2] Includes in-lieu payments by SRP and the future effects on taxes from assumed investment in Selective Catalytic Reduction: $796 million for the Proposed Action 3-Unit Operation and $531 for the 2-Unit Operation.

Future revenues in excess of $1,355 million would accrue to the Navajo Nation, local governments and public education, principally in Coconino County, in conjunction with Proposed Action 3-Unit Operation.

On an annual basis, the $43 million in payments accruing to the Navajo Nation would represent an increase of nearly 15 percent in the tribe's annual general revenues as compared to its 2014 annual revenues. The future revenues would not be sensitive to fluctuations in interest rates and energy commodity prices and would escalate in response to general inflation. The stability of revenues and adjustments for inflation represent advantages to the tribe. The corresponding total payments for the 2-Unit Operation are $986 million.

Under provisions of the NGS 1969 Lease with the Navajo Nation, sales to NGS are not subject to sales taxes levied by the Navajo Nation. Future TPT taxes received by businesses on sales to employees and other households whose income is indirectly supported by NGS operations would generate tax revenues. Approximately 32 percent of the total TPT receipts are distributed to counties and municipalities in the state. Consequently, local governments would benefit from these receipts.

3.18.4.3.1.3 Demographics and Communities

Impacts on local labor markets, population, housing and private and public sectors of the local communities are presented in **Table 3.18-34**.

Table 3.18-34 NGS Demographic/Community Impacts of the Proposed Action

Parameter	3-Unit Operation	2-Unit Operation
Labor Market	Supports jobs and lower unemployment in the regional economy, especially in Page and among Navajo living in the LeChee and Kaibeto chapters and elsewhere in the northwestern portion of the Navaho Nation. Possible new job opportunities for Navajo, likely concentrated in Window Rock, Fort Defiance, and other communities that function as service centers for the Navajo Nation.	Supports jobs and lower unemployment in the region, with fewer jobs supported in the Page economy. Unemployment higher in Page than with the 3-Unit Operation Possible new job opportunities with the Navajo Nation tied to payments from NGS; similar to, but of a smaller scale than for 3-Unit Operation. Above gains would be offset by cutbacks at NGS and ripple effects in Page, Flagstaff and broader regional economy. Cutbacks at NGS likely achieved via attrition, retirements, voluntary separation, transfers, and application of union work rules.
Population	Temporary population influx during overhauls and selective catalytic reduction installation. Little long-term change in regional population directly related to NGS. Increased Navajo Nation employment could promote higher on-reservation population.	Minor population declines foreseeable in Page / LeChee area due to reductions in local jobs and local spending. Potential emigration dampened by tendency among retirees or those accepting voluntary separation to maintain local residence.
Housing	Little long-term change in housing need in Page. Demand for temporary accommodations would increase during selective catalytic reduction installation. Housing demand may increase in Window Rock and Fort Defiance, but added jobs and income promotes affordability among Navajo.	Lower housing demand in Page; housing prices and rents may decline and the number of vacancies could increase. Seasonal demand for temporary accommodations would be lower due to changes in NGS overhaul schedule, but increase during selective catalytic reduction installation.

Table 3.18-34 NGS Demographic/Community Impacts of the Proposed Action

Parameter	3-Unit Operation	2-Unit Operation
Effects on local retail and service sector	Businesses on Navajo Nation and in nearby off-reservation communities, including Gallup, benefit from increased consumer spending supported by higher lease and additional payments. Businesses in Page would benefit from temporary boosts during overhauls and selective catalytic reduction installation. Effects of selective catalytic reduction installation could compete/ overlap with seasonal tourism demands.	Effects tied to higher payments to Navajo Nation would be similar to, but on a smaller scale than those for 3-Unit Operation. Gains in income and spending on the eastern portion of the primary segment of the study area would occur, but there would be declines in Page, Flagstaff, and Tuba City and Moenkopi areas due to the ripple effects of cutbacks at NGS.
Effects on public facilities and services	Demands and utilization of public facilities and service would continue consistent with established affected environment patterns.	Utilization of most public facilities and service would continue, but potentially at reduced levels in Page compared to established affected environment patterns. There would be an increase in demand for public assistance and other social services in Page and Navajo Chapters near NGS. Downward pressure on housing prices in Page could affect property taxes.

3.18.4.3.1.4 Sociocultural Conditions

Implementation of Proposed Action 3-Unit Operation would perpetuate most prevailing sociocultural conditions associated with NGS in the primary segment of the study area. One change influence would be the installation of Selective Catalytic Reduction. That project would introduce employment and population influxes into the Page community, similar to those associated with overhauls, but of longer duration. The longer duration raises a potential conflict with the seasonal tourism demand for temporary accommodations. selective catalytic reduction installation also would generate additional tax revenues in Page, Flagstaff, and to the Navajo Nation. At the same time, selective catalytic reduction installation may offer extended employment opportunities to some workers who have temporary employment in conjunction with the overhauls. To the extent that this occurs, it would represent an important local economic benefit.

Other sociocultural changes would occur in conjunction with the higher lease and additional payments to the Navajo Nation. The Navajo Nation might expand services, providing more Navajo workers with jobs, depending on how the Nation chooses to allocate the funds. Additional jobs could allow more Navajo families to remain on or return to the Navajo Nation.

NGS and employee participation in civic, service and charitable organizations likely would continue, as would the annual economic infusion associated with NGS overhauls.

Navajo, Hopi, and NGOs who advocate for a transition away from coal-fired generation to renewable or lower-emissions sources would be dissatisfied with the continued operations of NGS at current levels, as would those individuals and organizations concerned about air quality, human and ecological health, and climate change-related effects of the facility.

Implementation of Proposed Action 2-Unit Operation would support 1,616 direct, indirect, and induced jobs in the primary segment of the study area, as compared to the 2,164 jobs supported by the Proposed Action 3-Unit Operation. The differences in job availability may prompt out-migration of some workers and their families, and stresses on families as some workers then travel away for employment. New Navajo Nation jobs that could be added as a result of NGS Lease Amendment No. 1 (or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1) and other payments could offset some of the differences in job availability that would be associated with Proposed Action 2-Unit Operation. The lower number of direct jobs at NGS and many of the indirect and induced jobs are likely to affect the labor force residing in Page, LeChee, or Kaibeto. Jobs added in response to higher NGS payments would more likely be located in Window Rock and elsewhere. Differences associated with the installation of selective catalytic reduction on two units would include fewer jobs and construction would occur several years later than under Proposed Action 3-Unit Operation.

Participation in the civic, service and charitable organizations by SRP and active employees would likely be lower under a Proposed Action 2-Unit Operation than under Proposed Action 3-Unit Operation, but also could receive boosts from newly retired individuals who retain local residency. Multigenerational, extended family Navajo and Hopi households who rely heavily on the incomes provided by a working household member affected by lay-offs under Proposed Action 2-Unit Operation would find the changes particularly burdensome.

From a social perspective, the shutdown on one unit with the 2-Unit Operation and installation of selective catalytic reduction on the remaining units at NGS may temper the dissatisfaction among some Navajo, Hopi and NGOs who advocate for a transition to renewable or lower-emissions sources, and are concerned about air quality, human and ecological health, and climate change-related effects of the facility.

3.18.4.3.2 Proposed Kayenta Mine Complex

Implementation of the Proposed Action would require a continued supply of coal through 2044. From a socioeconomic perspective, few changes in overall operations would occur at the proposed KMC under the Proposed Action. Rather, differences in socioeconomic effects would result indirectly in response to changes in future production rates to supply coal to NGS. Changes in the pace of mining would affect labor needs, investments in capital equipment, the amount and location of future disturbance and mining, and future royalty, bonus and tax payments made by PWCC that help fund a variety of administration functions and services provided by the tribes, local governmental entities and public education districts.

Future employment effects of continued operations with the future changes as proposed are presented in **Table 3.18-35**. **Tables 3.18-36, 3.18-37,** and **3.18-38** address Labor Income and Public Revenue, Demographic and Community, and Social effects, respectively.

3.18.4.3.2.1 Operations and Employment

Annual coal supply requirements under the Proposed Action 3-Unit Operation would be up to 8.1 million tons per year, with some year-to-year variation in response to actual production needs, i.e., coal requirements decline during major overhauls at NGS. Installation of the selective catalytic reduction may increase required coal tonnages slightly. No major changes in labor force requirements to sustain annual coal production are anticipated. No future changes in the coal supply agreement affecting royalty and bonus payments, or groundwater use at the mine are assumed. A substantial increase in water fees, retroactive to 2015, is pending approval.[23] It is assumed that the new rate would be in effect as part of any Proposed Action Alternative.

[23] The terms of the new rate have not been released publically, pending final approvals.

Continued O&M of the proposed KMC would support up to 1,648 long-term direct, indirect, and induced jobs in the regional economy. Over the 25-year period of extended operations, those jobs would represent up to 41,200 job-years of employment.

Annual coal supply requirements associated with the Proposed Action 2-Unit Operation would be 5.5 million tons per year. Ongoing O&M of the proposed KMC would support an estimated 1,129 jobs in the primary segment of the study area. Over the 25-year period of extended operations, those jobs would represent 28,225 job-years of employment in the primary segment of the study area, 12,975 job-years fewer than would be supported by Proposed Action Unit-3 Operation. Achieving the cutbacks in staffing at the mine from the levels anticipated at the end of 2019 would be achieved through attrition, retirements, voluntary separations and possibly lay-offs. Any lay-offs from among workers represented by the United Mine Workers of America Local 1924 would be implemented in compliance with union work rules. The majority of area residents affected by the loss of job opportunity would be Navajos. A number of Hopi might be affected by cutbacks in tribal staffing in response to reductions in tribal royalty, coal bonus and water fee revenues.

Table 3.18-35 Proposed KMC Operations and Employment Impacts of the Proposed Action

Parameter	3-Unit Operation 547 MW	2-Unit Operation 540 MW
Operational		
Annual Coal Production – NGS Total (average)	8.1 million tons	5.5 million tons
Total coal production 2020 to 2044	203 million tons	138 million tons
Difference in total production (tons and years at current production rate)	NA	65.0 million tons less ~ 8.0 years
Annual groundwater use (acre-feet per year)	Up to 1,200 acre-feet per year	Up to 1,200 acre-feet per year
Total groundwater use: 2020 to 2057 [1]	Up to 32,500 acre-feet	Up to 32,500 acre-feet
Employment		
PWCC direct jobs	440	299
On-site contractor jobs	79	53
Tribal and NTUA jobs	309	214
Indirect/induced jobs [2]	820	563
Total jobs	1,648	1,129
Aggregate job-years (2020 to 2044)	41,200	28,225
Difference in total job-years compared to Proposed Action 3-Unit Operation	NA	12,975 / 31.5% less than for the 3-Unit Operation

[1] 2057 would be expected bond release. The total includes 2,500 acre-feet for post mining use but does not include water to be pumped for residential and livestock use on the Black Mesa.

[2] Estimates of the indirect and induced jobs derived using an IMPLAN calibrated for northeastern Arizona.

NA = not applicable

3.18.4.3.2.2 Labor Income and Public Revenues

Table 3.18-36 presents effects on labor income and the annual payments to the tribes, local governments, and local public education under the Proposed Action.

Under Proposed Action 3-Unit Operation, workers and households in the primary segment of the study area would realize a collective total of up to $110.7 million per year in labor income; an aggregate total of nearly $2.8 billion over the 25-year period. The annual sum is the equivalent of 1.1 percent of the total personal income of the 3-county region in 2013.

With a 2-Unit Operation, workers and households in the primary segment of the study area would realize collective labor income of up to $75.8 million annually; nearly $1.9 billion over the 25-year period. The annual total is equivalent to 0.8 percent of the total personal income of the 3-county region in 2013 and $873 million lower than under Proposed Action 3-Unit Operation.

As with NGS operations, extending the operating life of the proposed KMC to 2044 would provide current and retirement income for many households beyond the operating life of the plant. Those benefits take on added importance given the persistent high unemployment and poverty among the Navajo.

PWCC would make projected royalty, bonus, water fee and tax payments of more than $49 million annually under the Proposed Action 3-Unit Operation.[24] Future revenues accruing to the Navajo Nation, local governments and public education, principally in Navajo County, in conjunction with Proposed Action 3-Unit Operation are estimated in excess of $1.225 billion through 2044; payments to the Navajo Nation and Hopi Tribe would account for nearly $1.192 billion of the total. The comparable payments under Proposed Action 2-Unit Operation are estimated at $33.9 million annually and nearly $848 million through 2044.

Table 3.18-36 Proposed KMC Labor Income and Public Revenue of the Proposed Action

Parameter	3-Unit Operation	2-Unit Operation
Labor Income		
Annual [2015 USD]	$110.7 million	$75.8 million
Annual income - percent of 2013 3-county regional total	1.1%	0.8%
Aggregate Total 2020 to 2044	$ 2,768 million	$ 1,895 million
Difference compared to 3-Unit Operation	NA	$ 873 million less
Access to comprehensive fringe benefit programs	Access extended for current and a future generation of workers.	Similar to, but approximately 1/3 lower than for the 3-Unit Operation.
Long-term pension and retirement income	Substantial future income for many current and future workers.	Similar to, but approximately 1/3 lower than for the 3-Unit Operation.
Payments to the Tribes, Local Governments, and Education Support		
Annual PWCC lease, royalty and bonus payments [1, 2]	~$46.4 million	~$31.5 million
Annual water fees to the Navajo and Hopi (based on current rates) [3]	> $1.3 million	> $1.3 million
Annual property taxes paid by PWCC (average)	$1.33 million	$1.12 million
Aggregated combined PWCC payments (lease, royalty, bonus, water fees, and property taxes) 2020 to 2044	$1,225 million	$848 million
Difference compared to Proposed Action 3-	NA	$377.4 million lower / ~31%

[24] The projected annual payments are based on the current water fees paid by PWCC. A substantial increase in water rates, retroactive to 2015, is pending approval by the Hopi Tribal Council and the Secretary of the Interior. However, details of the new rate have not been released to the public.

Table 3.18-36 Proposed KMC Labor Income and Public Revenue of the Proposed Action

Parameter	3-Unit Operation	2-Unit Operation
Labor Income		
Unit Operation		
PWCC Scholarships, Community Support, and company and employee donations to charitable organization and campaigns	> $1.3 million – in 2013 Future amount unknown but would continue	> $1.3 million – in 2013 Future amount unknown but would continue
Federal Abandoned Mine Land and Black Lung Disability Programs		
Annual	$7.0 million	$4.8 million
Total: 2020 to 2044	$175 million	$120 million

[1] Projections of future royalties and bonuses are based on the existing contracts, with no assumptions regarding changes during future "reopener" negotiations between the tribes and PWCC.

[2] Coal bonus payments are not made annually. The annual figure includes an average bonus per ton based on the projected tons of coal mined.

[3] An increase in water rates, retroactive to 2015, is pending approval by the Hopi Tribal Council and the Secretary of the Interior. Details of the new rate have not been released.

NA = not applicable.

Despite lower future royalty and bonus revenues under the Proposed Action 2-Unit Operation than the amounts received under the existing lease, the Navajo Nation would realize net gains in revenues under a 2-Unit Operation due to the higher NGS lease and additional payments under Lease Amendment No. 1. Implementation of a 2-Unit Operation would, however, substantially reduce revenues to the Hopi Tribe as compared to those associated with production for ongoing operations through 2019. Because mining related revenues account for most of the Hopi Tribe's general fund budget, reductions in such revenues may necessitate cutbacks in tribal employment and service levels that affect the entire tribe.

The sale of coal to NGS by PWCC is not subject to Navajo sales taxes. However, total personal income supported by the 2-Unit Operation would in turn support lower taxable sales by businesses to vendors and by consumers, than would occur with the 3-Unit Operation. Most of the effects on retail sales would accrue to businesses in Page, Kayenta, Tuba City, Flagstaff, Gallup, and Window Rock. Changes in sales for establishments in Albuquerque, Phoenix, Farmington and other communities also would occur.

Extending the operating life of NGS would generate labor income, including retirement benefits, for the current and future workers hired at the proposed KMC during the 25-year period and for tribal jobs supported by such payments.

3.18.4.3.2.3 Demographics and Communities

Table 3.18-37 addresses the Demographic and Community effects that would result in conjunction with operational changes at the proposed KMC.

Table 3.18-37 Proposed KMC Demographic/Community Impacts of the Proposed Action

Parameter	3-Unit Operation	2-Unit Operation
Labor Market	Local labor market conditions would be largely unaffected by continued operation and annual production of 8.1 million tons of coal. Support for tribal employment could be sustained at levels comparable to those associated with operations at the end of 2019.	Fewer job opportunities could result in higher local unemployment. Cutbacks in Hopi tribal staffing likely due to reductions in funding to support Hopi Tribal government operation Staffing cutbacks at the proposed KMC would be achieved through attrition,

Table 3.18-37 Proposed KMC Demographic/Community Impacts of the Proposed Action

Parameter	3-Unit Operation	2-Unit Operation
		voluntary separation, retirement, and application of United Mine Workers of America work rules. Workers with technical skills and training that are laid off would likely go off-reservation to seek work/income.
Population	Little, if any, net effect on regional population.	Fewer jobs could spur out-migration. Many affected households likely would remain on reservation while wage earners seek off reservation employment, returning as work schedules and finances allow. Potential emigration effects dampened by strong cultural ties to family and land.
Housing	Little, if any, net effect on regional housing need.	Homes in vicinity of the proposed KMC largely are owner occupied by families with long-term roots in the area. Few vacancies expected; continued occupancy by extended family would be likely. Existing housing shortages and challenges in obtaining homesite leases also could mitigate against increases in vacancies.
Effects on local retail and service sector	Consumer spending for retail and service establishments would continue at levels comparable to that associated with historical operations.	Businesses in Kayenta and other nearby communities experience reductions in sales tied to lower consumer spending. Declining business revenues in Moenkopi, Tuba City and elsewhere due to cutbacks in royalty and bonus payments.
Effects on public facilities and services	Demand and utilization of public facilities and services would be consistent with established patterns at the end of 2019. Community water pumping costs would increase due to N-Aquifer drawdown resulting from increased community pumping and continued mine use. Drawdown following cessation of mining would result from continued community pumping (see Section 3.7). Residential water service within the proposed KMC lease area may become available in conjunction with the first phase of the Many Mules water project. N-41 realignment and improvements would be completed.	Cutbacks in Hopi tribal staffing and services likely due to reduced revenues. Demands for and utilization of public services would be affected due to emigration anticipated in response to job losses. Demand for public assistance and other social services may increase due to higher unemployment and lower income. Effects on community water pumping costs similar to those for Proposed Action 3-Unit Operation. N-41 realignment and improvements would be completed. Reductions in NTUA revenues from the mine; rate hikes for other customers could result.

3.18.4.3.2.4 Sociocultural Conditions

As shown in **Table 3.18-38**, under the Proposed Action 3-Unit Operation, the Navajo Nation and Hopi Tribe could sustain levels of local employment associated with revenue derived from the Kayenta Mine at the end of 2019, maintaining relatively high paying jobs for primarily Navajo workers and allowing current workers and families to remain on their historic lands and support an extended family. PWCC lease and royalty payments would support services and employment across the Navajo Nation and Hopi Reservation, and PWCC-supplied water, coal and road maintenance and support for scholarships, events and charities would likely continue. Implementation of Proposed Action 2-Unit Operation could result in similar same effects, but at scaled back levels.

Proposed Action 3-Unit Operation and 2-Unit Operation would both provide opportunity for future PWCC employment for lease area residents, other Navajos and the Hopi. Given the relatively low work force turnover at the Kayenta Mine, few job openings are anticipated on an annual basis. This could change under Proposed Action 3-Unit Operation as current employees become eligible to retire. Hopi Tribe members would continue to face the challenge imposed by a lengthy commute between Hopi villages and the proposed KMC. Under Proposed Action 2-Unit Operation, future job opportunities would be more limited due to possible cutbacks in staffing levels.

Reductions in the direct workforce at the proposed KMC would primarily affect the Kayenta, Shonto, Tuba City, Forest Lake, and Piñon Chapters. Secondary effects would be likely in the Page, Flagstaff, and Kayenta communities. The lower level of employment at the proposed KMC under the Proposed Action 2-Unit Operation would contribute to out-migration of Navajo workers and families, and stresses on families as wage-earners travel away from home for employment. The loss of income could pose high economic burdens on extended families who rely on incomes provided by the mine.

The continuation of mining under Proposed Action may require relocation or lump sum monetary compensation (for residences and/or improvements) for up to eight households, depending on the actual location of mining (PWCC 2012, et seq.). Although relocation may result in improved housing and infrastructure conditions, it can move families away from their customary use areas. Up to six relocations would occur under the Proposed Action 2-Unit Operation.

Coal royalties due to lower coal production under the 2-Unit Operation would adversely impact Navajo and Hopi government services and employment. Because Kayenta Mine-related revenues constitute a high percentage of Hopi Tribe revenues, the reduction in the proposed KMC-related revenues would be more severe for the Hopi. Reductions in services would adversely affect the quality of life for many Navajo and Hopi across both reservations.

Table 3.18-38 Proposed KMC Sociocultural Impacts of the Proposed Action

Parameter	3-Unit Operation	2-Unit Operation
Economic importance of KMC for the Navajo Nation and Hopi Tribe	Continuation of historical employment levels would allow workers and their families to remain on their historic lands and support extended families. PWCC lease and royalty payments for the proposed KMC would be comparable to historical levels, supporting services and employment across the Navajo Nation and Hopi Reservation. PWCC-supplied water, firewood, and coal, road maintenance and support for scholarships, events and charities would occur, at levels comparable to those occurring during at the end of the baseline period.	Employment at KMC under would be lower than under the 3-Unit Operation. Local employment of fewer workers could prompt out-migration of some Navajo workers and families, or increase the numbers of wage earners that travel long-distances for employment. Because many wage earners support extended families, economic hardships would likely be greater than for a similar off-reservation loss of employment. PWCC-supplied coal, water, firewood and services, and corporate and employee support for scholarships, community events and charities would occur, but likely at lower levels than with the 3-Unit Operation. Hopi Tribe employment and services would likely decrease, potentially resulting in out-migration of some Hopis.

Table 3.18-38 Proposed KMC Sociocultural Impacts of the Proposed Action

Parameter	3-Unit Operation	2-Unit Operation
Lease area resident and Hopi employment	Lease area residents and Hopi would have opportunities for the proposed KMC employment similar to historical opportunities.	Fewer employment opportunities for lease area residents and Hopi due to work force reductions at the proposed KMC.
Air quality, human health and safety, ecological health, and water quantity and quality	Continued concerns about the proposed KMC-related effects on the identified resources, particularly for residents of the proposed KMC lease area. Continued concern about depletion and degradation of the N-Aquifer.	Concerns about the proposed KMC-related effects on the identified resources would be comparable to those with a 3-Unit Operation. Continued concern about depletion and degradation of the N-Aquifer.
Relocation	Up to eight households may be relocated or receive lump sum compensation for residences and improvements.	Two fewer households may be relocated than under the 3-Unit Operation because parcel N-10 would not be mined.
Withdrawal of grazing lands	Withdrawal of additional grazing lands could increase strains on the affected grazing permit holders and further impact traditional cultural activities and lifestyles. Compensation for loss of grazing would continue. Reclamation of disturbed lands would continue.	Withdrawal of grazing lands would be lower, resulting in lesser impacts on the affected grazing permit holders. Reclamation of disturbed lands would continue, similar to under Proposed Action 3-Unit Operation No change in policies for compensation of loss of grazing, but fewer acres involved.
Homesite leases	Navajo process for obtaining homesite leases would be unaffected.	Navajo process for obtaining homesite leases would be unaffected.
Road safety, maintenance and dust	Continued concerns regarding road safety, dust, and flooding at low crossings for residents within and near the lease area.	Potential reduction in road safety and dust concerns in and near the lease area due to lower traffic volumes. Concerns about flooding at low crossings would be similar to those for the 3-Unit Operation.
Cultural Resources	Some traditional Navajo and Hopi would likely be dissatisfied with the continuation of mining and its potential effects on TCPs, places, and landscapes having cultural and religious significance.	Dissatisfaction levels would likely be comparable to those under Proposed Action 3-Unit Operation.
Cultural Values	Continued dissatisfaction among Navajo and Hopi who believe that mining and related disturbance and environmental effects are incompatible with Native American traditional values.	Dissatisfaction levels would likely be comparable to those under Proposed Action 3-Unit Operation.
Equity	Perceived inequities among lease area residents regarding the provision of water to entities in central Arizona, facilitated by local mining, and the lack of water service locally, may diminish if and when the Many Mules Water Project begins supplying water to lease area residents.	No appreciable differences as compared to Proposed Action 3-Unit Operation.

Table 3.18-38 Proposed KMC Sociocultural Impacts of the Proposed Action

Parameter	3-Unit Operation	2-Unit Operation
Setting	Effects of surface mining on the physical and cultural setting and quality of life in and near the lease area would be highest under Proposed Action 3-Unit Operation. Proposed Action 3-Unit Operation would likely result in the most dissatisfaction among local residents who value the traditional setting over job opportunities and PWCC-supplied coal, water, firewood and services.	Effects of surface mining on the physical and cultural setting and quality of life in and near the lease area would be lower than under Proposed Action 3-Unit Operation, but would still likely result in dissatisfaction among local residents who value traditional settings over employment opportunities and PWCC-supplied coal, water, firewood and services.

3.18.4.3.3 Native American Traditional Values and Concerns

NGS and the Kayenta Mine have been operating for over 40 years; consequently there has been extensive discourse about the effects of these two facilities on traditional Navajo and Hopi values. This discourse has been reported in a variety of studies, articles, interest group websites, and other secondary sources. The historical effects of the two facilities provide useful insights into the manner in which the Proposed Action and alternatives would be perceived to affect traditional Navajo and Hopi values.

This assessment assumes that historic Navajo and Hopi opinions about the compatibility of the mining and burning of coal on tribal lands for electrical power generation also would apply to the Proposed Action and alternatives.

It should be noted that the primary purpose of this discussion is to ensure other perspectives besides the predominant Western viewpoint are recognized, rather than provide an “impact assessment” per se.

Following are issues raised by those holding traditional values. Concerns expressed that address contemporary issues but also may be rooted in traditional cultural values are discussed in the Sociocultural Conditions and Trends subsection above.

- Changes to the land and the impact on traditional uses of the land including wildlife and native plants used for cultural purposes and for food.
- Land reclamation: some commenters expressed preference for reclamation for grazing; others expressed concern for the introduction of non-native species for reclamation purposes and the resulting changes in plant and animal species in the lease areas.
- Strong tangible and intangible ties to the land; the importance of land in the traditional sense and the belief that native people should be allowed to remain on their ancestral lands. To the native people it is “Mother Earth.”
- Impacts to traditional ways including loss of aquatic resources, native vegetation and wildlife for ceremonial, medicinal and other traditional uses.
- The mine is intrusive to the tribal residents and outside interests are controlling use of their native lands.
- Lack of access to water by the local population.

3.18.4.3.3.1 Navajo Concerns

The most commonly voiced concern expressed by Navajo individuals and NGOs during scoping and the subsequent listening sessions involved the potential effects of NGS and KMC emissions and activities on resident health. Regarding NGS, concerns were expressed for airborne emissions and coal combustion waste. Regarding the proposed KMC, concerns included blasting emissions, coal dust, and fugitive dust from both mining operations and traffic. A number of comments expressed concern that water use at the Kayenta Mine, combined with historic pumping of the Navajo Aquifer (N-Aquifer) to supply the former Black Mesa Mine and Black Mesa coal-slurry pipeline, has substantially depleted the aquifer, with associated adverse effects on springs, seeps, and wells in the Black Mesa area. A number of comments expressed concern for the relocation of residents and withdrawal of grazing lands, breaking traditional connections to the cultural practices and ceremonies linking traditional Navajo to their homes and birthplaces. Some residents expressed a preference for reclamation to accommodate grazing, a traditional cultural activity; others prefer returning disturbed land to their original vegetative state using nursery-grown native plants. Others are concerned about the potential for reestablishing plants used for ceremonial purposes. Comments regarding the proposed KMC also expressed concern for past treatment of sacred sites and family burials.

3.18.4.3.3.2 Hopi Concerns

The primary issues identified by Hopi tribal members include "concerns for air quality, water quality, and the indirect effects that air and water contamination might have on the ecosystem (i.e., animals and plants), and public health. Some Hopi tribal members also expressed serious concerns for the irreversible damage that mining causes to the natural environment, and the effect that these changes would have on community sustenance, traditional uses of the environment, and religious experiences associated with the land. Hopis are extremely concerned about the effect that past mining has had on their ancestral villages and burial sites, and they would like to see all ancestral sites protected. Disturbance of human remains by mining constitutes a significant impact on the spiritual wellbeing of the Hopi people. Finally, since the start of mining operations on Black Mesa, Hopis have persistently voiced concerns about the use of groundwater for mining. Some Hopi people are concerned about depletion to the aquifers, contamination of water, and the effect that groundwater pumping has on the overall health and well-being of the environment and the people" (Hopkins et al. 2016).

3.18.4.3.3.3 Navajo Generating Station

The proposed action would not result in any changes to the general physical environment related to the NGS and associated facilities from 2022 through 2044 plus decommissioning; however, it would continue the prior disturbance of the traditional setting, including that of the BM&LP Railroad that may be the basis for multiple cultural practices.

3.18.4.3.3.4 Proposed KMC

Under the Proposed Action, the Kayenta Mine permit area and former Black Mesa Mine would be combined into a single permit consisting of 62,930 acres; the combined area would be called the KMC. The Proposed Action would involve a continuation of mining, which would continue to alter the local environment. Lack of access, noise, dust and the concerns of pollution in areas of traditional significance would continue, and, to some extent, be expanded as new areas are mined.

Up to an additional 5,665 acres of tribal trust lands on the proposed KMC lease area would be mined under the Proposed Action. This disturbance would further alter the traditional setting within the KMC, which is the basis for multiple cultural practices. The disturbance would affect plants used for traditional purposes, and disturb ancestral sites and human remains. Up to eight additional households could require relocation or receive compensation for their homes and other improvements and up to six grazing areas would be withdrawn from active use.

3.18.4.3.4 Transmission Systems and Communication Sites

The STS and WTS transmission systems traverse land owned or managed by a combination of private, tribal, and governmental agencies. In addition, 19 existing radio communication sites support operations of the plant, railroad, and transmission systems. Most of the ROWs for these facilities are located in rural, generally undeveloped areas. In some locations the facilities are readily visible, but public visibility and awareness of the facilities in other areas is limited by access and terrain. These transmission lines and communications facilities are not unique in their presence on the landscape. In some locations the facilities are collocated within or near other linear systems (e.g., other transmission lines, pipelines, highways, or railroads). No specific social concerns about transmission lines and communication sites were identified during scoping.

Ongoing employment and other economic impacts of transmission lines and communications facilities of the type associated with this project include periodic inspection and maintenance of the infrastructure and ROW. Private, state and tribal ROW leases often generate rental income and the utility-owned interests are subject to property taxes levied by local governments, school districts, and other taxing jurisdictions. Operation and maintenance would continue unaffected under the Proposed Action for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

Table 3.18-39 summarizes key socioeconomic parameters and impacts associated with the transmission lines and communication sites that would be associated with the Proposed Action. There would be no appreciable differences in such socioeconomic impacts between the Proposed Action and conditions at the end of 2019.

Table 3.18-39 Socioeconomic Impacts of the Proposed Action Related to Transmission Systems Communications Sites

Parameter	Impacts
Operations	Existing lines, substations, and communication sites would continue to be utilized. Operations and maintenance would continue with little, if any, change. Overall utilization of these facilities by utilities and agencies due to reduction in NGS output under the 2-Unit Operation would have few, if any, socioeconomic effects because utilities would likely shift their dispatch and transmission procedures to optimize use of the available capacity.
Employment	An unknown number of jobs with utility companies, contract maintenance firms, local government, and local business currently associated with these systems. No discernible impacts on utility employment related to transmission line maintenance. No discernible changes in indirect and induced employment.
Construction	No new construction would be anticipated to occur after 2020. Conditions and operations would be essentially the same as under the historical operations, through 2019.
Labor Income and Public Revenues	No discernible changes in labor income associated with these systems would occur. Property taxes and ROW rental fees would continue on private, state and some tribal lands. Non-federal owners would begin paying ROW rents on federal lands. No substantive changes in demand on state and local facilities and services would occur.
Demographic / Community	No discernible changes in effects on population, housing, local retail and service establishments, or public facilities and services are anticipated.
Social	Current attitudes and concerns related to these facilities, if any, would likely continue.

3.18.4.3.5 Central Arizona Project

This subsection examines the prospective change in pumping energy costs for the CAP and the effects on water rates that would be associated with the Proposed Action operations. The analysis of future energy costs to CAP is based on future costs of NGS assuming continuation of the existing cost structure, and considering increases in operating costs over time. Incremental costs that would occur post-2019, including the cost of selective catalytic reduction installation, are estimated and summed with the base case costs to derive future costs. Costs are reported for three time periods: 2020 to 2025, 2026 to 2029, and 2030 to 2044. Those periods generally correspond to the assumed timing of operational changes affecting future NGS production costs. **Technical Supplement 3.18-A** at the end of this section documents the derivation of future energy costs associated with the Proposed Action operations and the alternatives.

3.18.4.3.5.1 Future Costs for Energy

Future costs of energy generated by NGS would increase under either Proposed Action operation. Those costs would be passed through to Reclamation and to the other NGS participants. In turn, Reclamation's energy costs would pass through to CAP and purchasers of surplus energy.

Primary factors driving future cost increases would include additional lease payments to the Navajo Nation, and capital, financing costs and operating costs associated with installation of Selective Catalytic Reduction. **Technical Supplement 3.18-A** at the end of this section provides additional detail on the derivation of future energy costs and the effects on CAP water costs.

<u>Lease Amendment No. 1 to the Indenture of Lease</u>

This amendment provides for a substantial increase in annual payments to the Navajo Nation by the NGS co-tenants. Allocating the Amendment #1 lease costs across future energy production yields incremental costs per MW hours of $2.50 and $2.70 for the 3-Unit Operation and 2-Unit Operation, respectively, over current NGS costs.

<u>Capital Cost of Selective Catalytic Reduction Installation and Operation</u>

Installation and operation of selective catalytic reduction pollution control equipment would be the single largest factor driving future increases in NGS energy costs. Based on assumed installation and financing costs and an $0.80 per MW hours allowance for increased operating costs (NREL 2012a), results in a projected cost of $4.40 per MW hours for the Proposed Action 3-Unit Operation and $5.20 per MW hours for the 2-Unit Operation (**Table 3.18-40** and **Technical Supplement 3.18-A**).

Table 3.18-40 Incremental Costs of Reclamation Power from NGS Associated with Selective Catalytic Reduction Installation

Parameter	3-Unit Operation	2-Unit Operation
Installed Capital Cost – Average (millions)	$796	$531
Term of debt financing	20 years	15 years
Annual debt service payment at 5% interest (millions)	$63.4	$50.7
Incremental Cost / MW hours, incl. $0.80 additional operating	$4.40	$5.20

Reclamation's share of the selective catalytic reduction capital investment would exceed $190 million for the 3-Unit Operation and $130 million for the 2-Unit Operation, exclusive of financing costs. Cost recovery would occur through billings to CAWCD and sales of surplus energy.

Table 3.18-41 summarizes the total annual energy supplied to CAP by NGS and the federal share of energy generated by NGS that would be available to sell as surplus. In addition to the energy from NGS, CAP uses approximately 300,000 MW hours of energy per year purchased by CAWCD from Reclamation (Hoover Dam) and other sources.

Table 3.18-41 Allocation of Federal Power from NGS for CAP

Alternative	NGS Energy[1] (MW hours/year)		
	Supplied to CAP	Available for Surplus	Total Generated
Proposed Action 3-Unit	2,696,000	1,472,000	4,168,000
Proposed Action 2-Unit	2,696,000	1,421,000	4,117,000

[1] Annual energy quantities are for a typical year without adjustment for the effects of minor or major maintenance overhauls.

NA = not applicable.

3.18.4.3.5.2 Future Energy Costs for Reclamation

Reclamation's future energy costs from NGS (on a per MW hours basis and rounded to the nearest $0.10) which serve as the basis for the costs billed to the CAP, are shown in **Table 3.18-42**. Under either Proposed Action configuration, costs associated with selective catalytic reduction installation would raise energy costs by more than 9 percent, with the lease amendment costs raising costs by another 4 to 5 percent.

Table 3.18-42 Future Energy Rates for Federal Power from NGS

NGS Operation	Annual Energy Rates / MW hours for CAP		
	2020 to 2025	2026 to 2029	2030 to 2044
Proposed Action 3-Unit Operation	$47.20	$53.00	$54.40
Proposed Action 2-Unit Operation	$49.40	$50.80	$57.50

The cost increases, on a per MW hours basis, which would accrue to Reclamation and to the CAP in conjunction with Lease Amendment No. 1 and selective catalytic reduction installation, would be comparable to those borne by the other participant in NGS.

3.18.4.3.5.3 Annual Pumping Energy Costs

Based on the CAP's annual power consumption, the CAP's annual energy costs for the Proposed Action 3-Unit Operation would increase from an average of $127.3 million in the 2020 to 2025 period to $144.8 million in the 2030 to 2044 period (see **Table 3.18-43**). The comparable cost range for the 2-Unit Operation are $144.8 million to $164.5 million. Included in the above is a $14.3 million annual allowance for the cost of power from Hoover Dam and energy purchases from the market.[25] Annual energy costs during the first and last periods would be higher under the 2-Unit Operation than those for the 3-Unit Operation due to higher selective catalytic reduction debt service associated with the latter. Over the 25-year extended operational life of NGS, the total pumping energy cost for the CAP would exceed $3.5 billion under the 3-Unit configuration and $3.6 billion under the 2-Unit configuration.

[25] The $14.3 million represents CAWCD's average expenditures for such energy in recent years. The availability and annual outlays for such energy are assumed to be unaffected by the Proposed Action.

Table 3.18-43 Annual Energy Charges to CAP for NGS Power

NGS Operation	Total Annual Energy Charges 2020 to 2025	2026 to 2029	2030 to 2044	Aggregate Total 2020 to 2044
3-Unit Operation	$127,250,000	$141,540,000	$144,780,000	$3,501,000,000
2-Unit Operation	$132,640,000	$136,150,000	$152,320,000	$3,625,000,000

Projected annual energy costs, on a per acre-foot of water basis, would increase from $80 during the 2020 to 2025 period to $90 during the 2030 to 2044 period for the Proposed Action 3-Unit Operation and from $80 to $94 for the Proposed Action 2-Unit Operation (**Table 3.18-44**).

Table 3.18-44 CAP Annual Energy Charges per acre-foot

NGS Operation	Annual Energy Charges / Acre-Foot [1,2] 2020 to 2025	2026 to 2029	2030 to 2044	Net Change 2020 to 2044
Proposed Action 3-Unit Operation	$80	$88	$90	$10
Proposed Action 2-Unit Operation	$83	$85	$95	$12

[1] Based on 1.6 million acre-feet/year.

[2] Equivalent rate for 2016 is $76 / acre-feet (CAWCD 2015a).

The projected $80 per acre-foot energy cost in 2020 under the 3-Unit Operation would represent a 5 percent increase over the $76 per acre-foot rate for 2016. The $88 per-acre foot costs in 2026 through 2029 would represent a 16 percent increase as compared to 2016 costs. Relative to the total annual costs for the four major categories of customers, the $4 per acre-foot incremental costs between 2020 and 2025 [$80 - $76 = $4] would represent increases of 2 to 5 percent (**Table 3.18-45**). The $14 per acre-foot increment in 2030 to 2044 [$90 to $76] would represent an effective increase of between 8 percent and 18 percent above current rates. Any future increases in the fixed O&M of CAP's rates would compound the effects of higher pumping energy costs.

Table 3.18-45 Comparative Impact of Energy Charges for CAP Customers

Parameter	Total Annual Energy Charges M&I Long-term Subcontract	M&I Non-subcontract and Recharge	Federal / Indian	Agricultural Settlement Pool
Firm 2016 Rate per acre-foot	$161	$184	$161	$76
$4 increase as a percent of 2016 firm rate	2%	2%	2%	5%
$18 increase as a percent of 2016 firm rate	9%	8%	9%	18%

For CAP customers, changes in energy costs would affect water costs, with the relative magnitude of change varying across the different categories of customers. Projected water costs under the Proposed Action 2-Unit Operation would be higher than under the 3-Unit Operation.

For M&I customers on long-term contracts, pumping energy costs represent approximately half of the total water rate. For many M&I customers, subsequent treatment, distribution, and system operation costs would further reduce the relative effect on final customers. Increases in water cost thus translate into higher costs of doing business, a reduction in consumer disposable income for other purposes, and higher costs for the public sector (i.e., for irrigation, public recreation, and potable uses). Secondary effects of such impacts could include reductions in employment and income. Higher water costs would promote current efforts towards conservation and improved irrigation efficiency.

The largest relative impact would be for users in the Agricultural Settlement Pool which pay only energy charges. Agricultural use of water represents approximately 25- to-30 percent of the annual water deliveries by CAP. The impact of the higher rates also would be substantial on Indian and non-Indian agricultural interest that use water for irrigation. Because agricultural producers are not able to set the prices for their commodities, increases in production costs typically come from the “bottom line” (i.e., lower farm income). Increased production costs and lower income may result in farming operations being scaled back, changes in cropping patterns or the amount of land in production, or in extreme instances, could result in cessation of farming.

For CAP-affected Indian tribes receiving water through CAP and customers in the agricultural settlement pool, energy costs represent their total current water rate. Most water for these customers is likely used untreated for irrigation purposes although users may incur additional distribution and application costs. For these users, increases in water rates would raise production costs and lower farm income. For some CAP-affected Tribes, reductions in farm income could affect the availability of revenues to support tribal operations and service provision. Higher energy rates also could hamper CAP-affected Tribes’ plans to support future commercial and industrial development uses and population growth, and their ability to reestablish traditional irrigation-based agriculture on their reservations. Although higher water rates would not affect the capacity of the CAP to deliver water to the Tribes, higher costs may be viewed as effectively affecting their ability to access that water. Beyond a strictly economic issue, some Tribes may view these effects within the context of Reclamation’s obligations under various water settlements.

For individual Tribes and users, higher water costs could result in reductions in the quantity of water used, acreages under cultivation, changes in crops raised, and cutbacks in farm employment. As with M&I users, higher water costs also could promote conservation and efforts to improve irrigation efficiency. Higher rates for CAP water could prompt some current users to resume or increase groundwater pumping. Another foreseeable consequence of higher rates would be decisions by some private landowners to convert agricultural lands to other land uses. [26]

CAP water users would face potential further indirect consequences from increases in energy costs as a result of lower revenues that would accrue to the Lower Colorado River Basin Development Fund (see Section 3.18.3.3). Surplus energy sales of the federal share of NGS power serve an important role in CAP financing and in meeting federal obligations under various settlement agreements with Indian tribes in the area. In recent years, gross surplus sales revenue has averaged approximately $35 million annually. Net revenues have been much lower, contributing about one-fourth of CAPs annual repayment obligation. Such sales are largely contingent upon power from NGS being cost competitive with the cost of power from other sources and availability during periods of peak demand. Consequently, future cost increases for NGS power could erode the potential for and realizable revenues from future surplus energy sales As noted above, reductions or the loss of such revenues would pose a financial risk to CAP’s non-Federal water users that would bear a higher financial burden associated with debt repayment.

[26] An assessment of the extent and timing of these potential tertiary effects is beyond the scope of this NEPA analysis due to a lack of readily available information about the individual landowners, the numerous alternatives under consideration, and uncertainties about other factors that could be as or more influential in affecting future development conditions in the three-county CAP-affected region.

For M&I users, the effects of higher energy rates on the ultimate consumers are tempered somewhat by the fact that the water costs represent a relatively small share of the ultimate cost of potable water to the consumer. Water treatment, storage, distribution and system administration account for the majority of ultimate costs to the consumer.

A third major group of customers includes the Central Arizona Groundwater Recharge District and the Arizona Water Banking Authority. The increases in energy costs would result in a direct increase in the water acquisition costs for these two entities. Both entities are funded by a combination of public funds and user and water management fees. Increases in costs may require increases in fees, use of reserves, or other means to address the higher costs.

3.18.4.3.6 Project Impact Summary – All Project Components

Approving the extended operational life of the NGS and proposed KMC would have important and far-reaching socioeconomic consequences for northeastern Arizona, and in particular the Navajo Nation, Hopi Tribe and many individual members of the two tribes. The impacts of those approvals would extend to the CAP-affected tribes and other CAP customers by providing a continuous and reliable source of energy to operate the CAP system at predictable rates that also could support future sales of surplus energy yielding revenues to support the Development Fund. **Table 3.18-46** summarizes the critical socioeconomic effects associated with the Proposed Action operations.

Table 3.18-46 Impact Summary for the Proposed Action Operations

	NGS Configuration	
	3-Unit Operation	**2-Unit Operation**
Operations		
Federal Energy from NGS (TW hours/year)	4.17	4.12
Coal Used – NGS Total (million tons)		
Annual	8.1	5.5
Aggregate 2020 to 2044	203	138
Employment		
Total Regional Jobs (direct, indirect, and induced) – Typical Year	3,812 jobs	2,745 jobs
Aggregate job-years – 2020 to 2044	95,303	68,617
Labor Income and Public Revenue		
Annual Labor Income (millions)	$260.4	$186.5
Aggregate Labor Income: 2020 to 2044 (millions)	$6,510	$4,663
Access to fringe benefit programs and long-term retirement income	Access to benefits and retirement income extended for current and a future generation of workers.	
Aggregate lease and other payments to the Navajo Nation, Hopi Tribe, local governments and public education: 2020 to 2044 (millions)	$2,554	$1,797
Net revenue effects to the Navajo Nation and Hopi Tribe as compared to end of 2019	Navajo Nation – much higher Hopi Tribe – unchanged	Navajo Nation – higher Hopi Tribe – much lower

Table 3.18-46 Impact Summary for the Proposed Action Operations

	NGS Configuration	
	3-Unit Operation	**2-Unit Operation**
Demographics/Community		
Air quality, human health and safety, ecological health, water quantity and quality, and elements of traditional lifestyles and social stability.	Provision of a substantial number of well-paying jobs would allow many Native American workers and their families to achieve or maintain a higher material standard of living, remain on their respective reservations, and support extended families. NGS and PWCC would provide substantial support for educational scholarships and community charitable causes in northeastern Arizona. Concerns about the effects of NGS emissions on air quality, visibility, climate change, and human and ecological health would persist. Navajo, Hopi, and NGOs who advocate for a transition away from coal-fired generation to renewable or lower-emissions sources would be dissatisfied with the continued operations of NGS. Concerns for health and ecological effects of KMC emissions, coal dust, fugitive dust, and coal fires and potential related effects on contaminating soil, water, and food sources would persist. Concern about potential depletion and degradation of the N-Aquifer associated with proposed KMC pumping and resultant effects on wells, springs and seeps would persist. PWCC-supplied water, firewood, coal, road maintenance and emergency medical services would continue to benefit residents of the proposed KMC area, and in the case of coal and water, nearby Navajo chapters and Hopi villages. Up to 8 additional household relocations could occur in the proposed KMC lease area under 3-Unit Operation and additional six grazing areas would be withdrawn from active use. Two fewer relocations would occur under 2-Unit Operation and fewer grazing lands would be withdrawn. Effects of surface mining on the physical and cultural setting and quality of life in and near the lease area would be higher with a 3-Unit Operation. Future operations would likely perpetuate dissatisfaction among local residents who value the traditional setting over job opportunities and support provided for tribal government and services and PWCC provided services. Most of the types of concerns outlined above would occur under either Proposed Action operation. Support for local economic and social stability would be stronger for the 3-Unit Operation than with the 2-Unit Operation.	
CAP Pumping Energy Charges		
Annual 2030 to 2044 (millions)	$144.8	$152.3
Aggregate 2020 to 2044 (millions)	$3,501	$3,625
Primary reasons for higher costs	Selective catalytic reduction installation costs, including financing, are the primary factor. Higher lease costs to the Navajo Nation, representing the first major increase since the NGS was built, also important.	

The summary assessment of impacts, as they relate to the specific issues defined in Section 3.18.4.2 above follow.

3.18.4.3.6.1 Regional Employment and Wages for the Navajo Nation and Hopi Tribe

Because of the many jobs and personal income that would be supported by the Proposed Action, the project related impacts on regional employment and wages would be major under either operation, particularly as related to the two tribes. Employment and income under the 3-Unit Operation would be higher than that expected at the end of 2019, while that under the 2-Unit Operation would be slightly lower than the levels expected at the end of 2019. The economic impacts would be particularly important because of the persistent unemployment and poverty in the region.

3.18.4.3.6.2 Demographic, Economic, Attitudes, and Social Organization Trends on Navajo and Hopi Populations

In addition to persistent high unemployment, limited job opportunities, and low personal income, traditional uses of the land and cultural ties to homesites and customary and traditional use areas among the Navajo and Hopi influence contemporary sociocultural conditions in the study area. Proposed Action-related income and access to fringe benefits, including retirement income, would support social stability for some Navajo and Hopi. At the same time, the continued operation of the NGS and the proposed KMC and related perceptions of environmental, health and cultural effects would result in dissatisfaction for some members of the two tribes and NGOs. These impacts would range from major to moderate.

3.18.4.3.6.3 Lease Fees, Royalties, Water Fees, and Other Payments to the Navajo Nation and Hopi Tribe

Project-related payments to the Navajo Nation and Hopi Tribe account for large portions of their respective general fund revenues to support governmental options, particularly for the Hopi. Future payments, including those to other local governments and to support public education, of more than $2.5 billion for the 3-Unit Operation and nearly $1.8 billion for the 2-Unit Operation would result. Given the magnitude of those revenues and few opportunities to replace those revenues with revenues from other sources, the fiscal impacts of operations under either Proposed Action would be major.

3.18.4.3.6.4 Social Fabric and Values that Provide Incentives for Younger Tribal Members to Remain on the Reservation

Future private and tribal employment opportunities and income effects associated with the Proposed Action and the economic support for households living on the reservations would provide incentives for younger tribal members to remain on the reservations. The impacts would be major because of the limited availability of foreseeable comparable opportunities and incomes from other employers.

3.18.4.3.6.5 Future Costs of Power Required for CAP Pumps and Economic Impacts due to Reductions in Surplus Revenues for the Development Fund

Pumping energy costs for the CAP would increase under either Proposed Action operation; by up to 18 percent (Proposed Action 3-Unit Operation) to 25 percent (Proposed Action 2-Unit Operation) as compared to the 2016 base rate of $76 per acre-foot of water delivered. The likely impacts of those increases would comprise a minor to moderate impact for users; moderate for the agricultural interests who pay only pumping energy costs and for the CAP-affected Tribes who used water for agricultural irrigation, minor for those M&I customers that subsequently treat, distribute and sell water to final consumers. Either Proposed Action would provide a continuous and reliable source of energy to operate the CAP system at predictable rates that supports the opportunities for future sales of surplus energy yielding revenues to support the Development Fund.

3.18.4.3.6.6 Native American Traditional Values

Air, water, land, traditional plants, cultural resources, homes and subsistence farming, gathering, and grazing activities that would be affected by NGS and the proposed KMC under the Proposed Action are considered important in the context of Navajo and Hopi traditional values. Navajo and Hopi who view mining and burning of coal on tribal lands, and use of tribal water for mining, as incompatible with their respective traditional values have voiced opposition to the Proposed Action.

Others have voiced support for the Proposed Action, pointing to the economic, employment, and fiscal benefits that would be generated for the two tribes. It could be assumed that those voicing support believe that mining and burning of coal for electric power generation and use of tribal water for mining could be compatible with their traditional values.

3.18.4.3.7 Cumulative Impacts

3.18.4.3.7.1 Navajo Generating Station and Proposed Kayenta Mine Complex

The contributions of the NGS and proposed KMC to cumulative effects within the cumulative impact study area are described below.

The primary cumulative impact analysis area for socioeconomics includes the Navajo Nation, Hopi Reservation, and northern Coconino and Navajo counties, Arizona, with a focus on the Navajo chapters and portions of the Hopi Reservation surrounding NGS and proposed KMC and the nearby off-reservation communities in the two counties, particularly Page. The communities, residents, and tribal and local governments in this area share economic dependencies on tourism and travel, natural resources, the influences of federal expenditures, and a general setting that is remote from major metropolitan areas. Localized areas within the region vary considerably in terms of access to employment opportunities, basic retail trade and services, health care, and water and electricity.

Given the considerable distances between communities and limited size and availability of services within the interior of the region, cumulative socioeconomic effects can arise when effects of projects that are spatially distant from one another jointly impact the same community(ies). The potential for cumulative effects for spatially and even temporally separated projects is particularly true with respect to fiscal effects on tribal and local governments, which often involve multi-year budgeting and expenditure cycles. Consequently, cumulative fiscal effects could materialize over several years, even in instances of limited direct coincidence in timing of events or actions among different sources.

For socioeconomics, the residual and continuing effects of past and present actions are manifest in the settlement, land use, and development patterns that are evident on the landscape, in established political and tribal boundaries, types and location of major economic activities, and existing demographic and sociocultural conditions (see Section 3.18.3). Activities that were instrumental in establishing the existing cumulative environment for social and economic conditions in the region include the following:

- Construction and operation of the Glen Canyon Dam, Lake Powell National Recreation Area, and the highway crossing of Glen Canyon.
- Establishment of the community of Page to support construction of the Glen Canyon Dam, and provide services for recreational uses of Lake Powell.
- The growth of nearby communities that are home to many workers for NGS and Kayenta Mine (Page, LeChee, Kayenta, Shonto, Forest Lake, and Pinon).
- Construction and operation of seven electrical generating stations in the northeastern Arizona and northwestern New Mexico, along with coal mines to supply those generating stations in the 1970s.
- Completion of a new east entrance station and reconstruction and paving of Desert View Drive at Grand Canyon National Park, which increased visitor flow to/from/through Page and other national parks and monuments and cultural attractions in northeastern Arizona.
- Operation and the subsequent closure of the former Black Mesa coal mine and Black Mesa Pipeline's coal-slurry pipeline.

The residual effects of many of those activities and actions will continue to influence future socioeconomic conditions in the region.

As a part of the current assessment, three individual projects (Four Corners Power Plant and Navajo Mine [New Mexico], San Juan Generating Station and San Juan Mine [New Mexico], and Cholla Power Plant [Navajo County, Arizona] and other similar activities located in and near the primary segment of the study area (the Escalante, Coronado, and Springerville generating stations and El Segundo, Navajo, and Lee's Ranch mines in northeastern Arizona and northwestern New Mexico) were identified as having potential to result in cumulative socioeconomic effects with those associated with the Proposed Action. Although not all of these are located on the Navajo Nation, collectively these facilities contribute to the region's economic base and indirectly to the ongoing fiscal and economic stability of the Navajo Nation and northwestern Arizona.

The foreseeable socioeconomic impacts associated with the other facilities include temporary effects related to closure of some units and converting other facilities to natural gas. Long term, these changes will result in reductions in regional coal demand in northwestern New Mexico, lower employment in the electrical generation and mining industries, lower local tax revenues and the possibilities of population outmigration and lower housing demand.

The contrast in futures between economic contractions and associated socioeconomic effects for the other projects and the stability associated with the Proposed Action 3-Unit Operation are somewhat inconsistent with typical perspective of additive and concurrent socioeconomic effects associated with growth and new development. In this case, because the NGS and Kayenta Mine are already established and no major changes in operations are proposed, implementation of the Proposed Action 3-Unit Operation would contribute to economic and social stability in the western part of the Navajo Nation, and on the Hopi Reservation and northwestern Arizona. Moreover, the increased tribal revenues associated with the Proposed Action 3-Unit Operation would help offset the effects of employment cutbacks and reductions of revenues that occur from the sequential retirements of other generating stations and the associated coal mines. The Hopi Tribe would not experience similar effects because it has little fiscal and economic dependency on the other operations.

Under the Proposed Action 2-Unit Operation, the employment and social effects of taking one unit offline would decrease contributions to regional economic and social stability in comparison to that under the Proposed Action 3-Unit Operation. However, fiscal payments to the Navajo Nation would be higher than those being paid under the existing lease.

Regarding cumulative sociocultural conditions within the western part of the Navajo Nation and the Hopi Reservation, past sociocultural influences have included the Navajo livestock reduction programs of the 1930s and 1940s, the Bennett Freeze, which effectively prohibited new development, including extension of utilities, road improvements, and even maintenance and repairs of existing properties across the southwestern portion of Navajo-Hopi Partitioned lands, and the passage of the 1974 Navajo-Hopi Land Settlement Act, which resulted in relocation of thousands of Navajo and a small number of Hopi from the designated partitioned lands (see Section 3.18.3.1 for a discussion of general sociocultural trends on the Navajo Nation and Hopi Reservation). Within the Kayenta and former Black Mesa mine lease area, households have been relocated or received compensation for their residences and improvements since mining was initiated. Additionally, grazing lands have been withdrawn in active mining areas, and the grazing permittees compensated for withdrawn lands.

Directly and indirectly, NGS and the Kayenta and former Black Mesa mines have provided a source of employment and income for many Navajo and Hopi workers during their operations, which has improved the material standard of living for these workers and allowed them to remain on their respective reservations. The payments of these facilities to the Navajo Nation and Hopi Tribe have supported the provision of Tribal services and the development of Tribal infrastructure and facilities.

Development and operations of NGS and the Kayenta and former Black Mesa mine also have contributed to the change in the sociocultural setting that is occurring across the Navajo Nation and Hopi Reservation.

Residents residing in the vicinity of the Kayenta and former Black Mesa mine have coexisted with mining activities and traffic, and the cumulative change in the landscape and traditional setting on a daily basis for over 40 years. There is a history of concerns voiced by some residents and others about the mines' air quality, water quantity and quality, and health effects, the treatment of cultural properties, and the perceived incompatibility of coal mining with traditional values. At the same time some area residents and others have supported the mines for the employment and other amenities that they have provided. Based on comments received during meetings with area residents, support for mining and concern for the effects of mining exist within the same household and at times, the same commenter.

Reasonably foreseeable future actions contributing to cumulative effects include implementation of the Proposed Action, which under both 3-Unit Operation and 2-Unit Operation would result in a continuation of the above referenced effects on sociocultural conditions. The potential for prolonged drought effects also could further diminish the ability for Navajo and Hopi participation in gazing and farming activities, and contribute to continued off-reservation migration.

Conversely, implementation of the Proposed Action would support continued employment, and allow the holders of direct, indirect, and induced jobs supported by the two facilities to remain on their respective reservations. Payments by the two facilities to the two tribes also would support continuation of tribal services and the development of new infrastructure and facilities, depending on tribal use of those revenues. These latter effects would be higher under the 3-Unit Operation than the 2-Unit Operation.

Based on scoping comments, published articles, and interest group websites, coal mining and coal-fired power plants, including the Four Corners Power Plant and Navajo Mine, the proposed Desert Rock Power Plant, and the historic and present operations of NGS, the Kayenta Mine and the former Black Mesa Mine and Coal Slurry Pipeline have all been considered by some Navajo and Hopi to be incompatible with their respective traditional values. Other Navajo and Hopi have supported past and present operations, as evidenced by their approval of the leases over the past 40-year period. It is assumed that the support was associated with the economic, employment, and fiscal benefits that have been generated for the respective tribes. It also is likely that some Navajo and Hopi who have supported past and present mining and burning of coal for electric power generation and use of tribal water for mining believed that these activities could be compatible with their traditional values.

While no major reasonably foreseeable actions are slated for the Navajo chapters surrounding NGS, or the chapters and area of the Hopi Reservation surrounding the proposed KMC, the past, present and proposed future operations of those facilities through 2052 all contribute to the perceptions of their impacts on Navajo and Hopi traditional tribal values.

3.18.4.3.7.2 Transmission Systems and Communication Sites

These transmission lines and sites exist; therefore, the continuing effects are limited because no construction is proposed under the Proposed Action Alternative. Operation of both lines and the communications sites is foreseeable under all action alternatives. Therefore, no cumulative social and economic effects of consequence would be expected to arise in conjunction with these transmission lines and communication sites.

3.18.4.3.7.3 Central Arizona Project

CAP's service territory is expansive and largely urban in nature. The Phoenix metropolitan area has been among the fastest growing areas in the nation for more than 20 years. The availability of CAP water has provided an alternative to the use of groundwater for a large portion of that growth.[27] Growth is expected to continue (see Section 3.18.3.3 above), with substantial new development occurring in conjunction with that growth. While occurring in the same time frame and location as the CAP, few if any of those changes would trigger cumulative effects on CAP revenues and expenses. However, the potential for cumulative effects affecting CAP water rates does arise in connection with events that are totally beyond local control: future water flows in the Colorado River and the potential for shortages.

Decreases in water deliveries would occur under a declared shortage on the Colorado River, such that fixed O&M costs need to be recovered based on a lesser quantity of water deliveries. Preliminary assessment from CAWCD is that rates could increase by as much as $20 per acre-foot [25 percent] based on Stage I shortage conditions [reduction of 320,000 acre-feet withdrawn]. Stage II or Stage II shortage conditions would result in further increases in O&M rates, i.e., by as much as $38 per acre-foot, or 43 percent under a Stage III shortage (CAWCD 2015c,d).

Potential further indirect effects of water shortages include reductions in the availability of power generated at Hoover Dam. The extent to which Colorado River shortages affect Hoover power availability for CAP, and the cost implications of any changes in availability is uncertain. However, to the extent that power availability is curtailed, energy costs could increase as CAWCD secures replacement power from other sources.

The contributions of the Proposed Action to cumulative socioeconomic effects would be moderate to major because the incomes for residents and payments to the Navajo Nation are substantial and would provide a measure of revenue stability at a time when revenues from other sources may decline.

3.18.4.4 Natural Gas Partial Federal Replacement Alternative

3.18.4.4.1 Navajo Generating Station

Implementation of a PFR Alternative presupposes continued operation of the NGS, Kayenta Mine, and continued use of the transmission lines and communications sites. Furthermore, the PFR Alternatives would affect only the federal share of NGS power and energy. No other changes in ownership, allocations of energy and power, or other characteristics of the NGS and other facilities are assumed in the EIS. The socioeconomic effects of the PFR alternatives would be the combined effects attributable to Proposed Action 3-Unit Operation or Proposed Action 2-Unit Operation and the incremental changes in effects of the specific PFR alternative.

Implementation of the Natural Gas PFR assume NGS output would be curtailed by between 100 MW and 250 MW on an on-going basis; NGS would operate below its maximum design capacity on a long-term basis. The upper end of the range would be equivalent to 43 percent of the gross Federal share of NGS output. Purchased power would be dedicated to meet CAP energy needs. Between 0.88 TW hours and 2.19 TW hours of energy would be sourced from the grid through a power purchase agreement (**Table 2-9**). NGS generated power would supply the remaining CAP demand and the remainder would be available for sale as surplus to support the Development Fund. Projected annual energy production at NGS and the allocation of that energy between CAP needs and availability for sale as surplus, and the corresponding annual coal use are shown in **Table 3.18-47**. Sales of surplus energy would be contingent upon future market conditions and NGS surplus power being cost competitive.

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[27] The use of CAP water to reduce groundwater pumping in the three-county CAP service area was described in Reclamation's 1972 and 1982 EISs on the CAP.

Table 3.18-47 Annual Energy Output and Coal Use for the Natural Gas PFR Alternative

Configuration	Proposed Action	Natural Gas PFR 100 MW Replacement	Natural Gas PFR 250 MW Replacement
3-Unit Operation, 547 MW Federal Share			
Federal Energy from NGS (TW hours/year) [1]	4.17	3.29	1.98
Federal Energy Supplied to CAP (TW hours/year)	2.70	1.82	0.51
NGS Energy Available as Surplus (TW hours/year)	1.47	1.47	1.47
Annual Tons of Coal Used – NGS Total (million tons) Differences [percentage] [2]	8.1 NA	7.7 -5%	7.1 -12%
2-Unit Operation, 540 MW Federal Share			
Federal Energy From NGS (TW hours/year)	4.12	3.24	1.93
Federal Energy Supplied to CAP From NGS(TW hours/year)	2.70	1.82	0.51
NGS Energy Available as Surplus (TW hours/year)	1.42	1.42	1.42
Annual Tons of Coal Used – NGS Total (million tons) Differences [percentage] [2]	5.5 NA	5.1 -7%	4.5 -18%

[1] TW hours/year = terawatt-hours per year. 1 terawatt equals 1,000,000,000,000 watts.
[2] Differences in tons of coal are relative to the base tonnages for the corresponding Proposed Action 3-Unit Operation or 2-Unit Operation.

NA = not applicable.

Annual coal requirements for the Natural Gas PFR would be between 0.4 million and 1.0 million tons lower than those with the respective Proposed Action operations. Reductions in coal requirements for the Natural Gas PFR with the 2-Unit Operation would be in addition to the 2.6 million tons per year reduction associated with retirement of one unit with the 2-Unit Operation.

Fewer jobs and lower labor income, tax revenues and other economic effects in the primary segment of the study area would be associated with the Natural Gas PFR Alternative, as compared to corresponding Proposed Action operation. Implementation of this alternative presumes power purchases from existing generating sources located outside the region with resulting cutbacks in NGS staffing due to long-term curtailment of energy generation. Increases in lease and additional payments would still accrue to the Navajo Nation.

In general, the effects for a 3-Unit Operation with a 100-MW reduction would not differ substantially from those under Proposed Action 3-Unit Operation, for although it would represent a substitution of energy generated by natural gas for 18 percent of the federal share presently generated by coal, it represents 4.4 percent of NGS's total rated capacity. On the other hand, a 250-MW reduction under a 2-Unit Operation would represent a net reduction of 44 percent in the overall capacity and output of NGS as compared to operations at the end of 2019. The key socioeconomic effects associated with the Natural Gas PFR Alternative include the following:

- Net job losses in regional employment and increases in unemployment would occur under this alternative, the magnitude increasing with higher levels of replacement power.

- With the Natural Gas PFR 3-Unit alternatives, NGS related employment and income in the primary segment of the study area would be between 4 percent (100 MW) and 8 percent (250 MW) lower than for the Proposed Action 3-Unit Operation and total labor income in the region over the 25-year period would be between $180 million and $407 million lower.
- With the Natural Gas PFR 2-Unit alternatives, NGS related employment and income in the primary segment of the study area would be between 5 percent (100 MW) and 10 percent (250 MW) lower than for the Proposed Action 3-Unit Operation and total labor income in the region over the 25-year period would be between $135 million and $357 million lower. These differences would be in addition to those that would result from the closure of one unit.
- Total lease and additional payments to the Navajo Nation by NGS under Lease Amendment No. 1 (or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1) for the 25-year period would be the same as under the corresponding Proposed Action operations - $1,075 million for the 3-Unit NGS option and $793 for the 2-Unit NGS option, provided the participants maintain NGS's current generator capacity ratings filed with the U.S. Energy Information Administration (EIA) – see the next item below.
- Under the Natural Gas PFR, the participants may have an option to lower the capacity ratings for NGS based on a consistent daily percentage reduction in output that would take into account the amount of energy procured by that CAP from other sources. Doing so could lower the additional payments made to the Navajo Nation under the lease amendment, resulting in potential cost savings and lowering the cost of NGS energy. The opportunities for such an action would increase at higher quantities of replacement and curtailment. No such adjustments are assumed for this assessment.
- Residents of LeChee, Kaibeto, Page, and Flagstaff, would be more likely to experience unemployment, with lesser effects occurring in the Tuba City and other communities.
- The potential for other socioeconomic effects, including lower housing demand and downward pressures on housing prices, would generally increase with higher levels of replacement power.
- Extending the operating life of the NGS under the Natural Gas PFR Alternative would allow more workers to accrue retirement benefits that would be realized beyond closure of the mine. The larger cutbacks for the Proposed Action 2-Unit Operation and 250 MW of replacement power would reduce such benefits.
- Higher levels of replacement power from natural gas, combined with retirement of one unit under Natural Gas PFR Alternative could ease public concern about environmental and health effects and contributions to climate change.
- The Natural Gas PFR Alternative could reduce NGS and employee participation in civic, community, and charitable initiatives.
- Higher NGS lease and other payments to the Navajo Nation would still be realized under this Alternative.
- The primary segment of the study area would not realize any economic or social effects directly associated with the purchase of power from the grid because the sources of such power are assumed to be outside the primary segment of the study area and already in existence.

Table 3.18-48 discloses the range of socioeconomics consequences associated with the Natural Gas PFR Alternative, focusing on those differences from those associated with the Proposed Action 3-Unit Operation.

Table 3.18-48 Socioeconomic Impacts of the Natural Gas PFR Alternative Related to NGS under the Natural Gas PFR Alternative

Parameter	NGS Configuration and Replacement Power			
	3-Unit Operation		2-Unit Operation	
	100-MW	250-MW	100-MW	250-MW
Employment				
New Regional Jobs Tied to Alternative Power	0	0	0	0
Total Regional Jobs – Typical Year	2,077 87 fewer than Proposed 3-Unit Operation	1,999 165 fewer than Proposed 3-Unit Operation	1,535 81 fewer than Proposed 2-Unit Operation	1,453 163 fewer than Proposed 2-Unit Operation
Aggregate job-years (direct, indirect, and induced) – 2020 to 2044	51,935 4% less than Proposed Action 3-Unit Operation,	49,985 8% fewer than Proposed Action 3-Unit Operation	38,385 5% less than Proposed Action 2-Unit Operation	36,335 10% less than Proposed Action 2-Unit Operation
Labor Income and Public Revenue				
Annual Labor Income	$142.6 million	$133.5 million	$105.4 million	$96.5 million
Aggregate Labor Income: 2020 to 2044	$3,565 million	$3,338 million	$2,635 million	$2,413 million
Total NGS lease and other payments to the Navajo Nation: 2020 to 2044 [1]	$ 1,075 million Same as Proposed Action 3-Unit Operation.	$ 1,075 million	$ 793 million Same as Proposed Action 2-Unit Operation	$ 793 million
Aggregate property tax and in-lieu pymts: 2020 to 2044: Coconino County / Public education	$ 280 million Same as Proposed Action 3-Unit Operation	$ 280 million	$ 193 million Same as Proposed Action 2-Unit Operation	$ 193 million
Additional lease or tax income from PFR Alternative	None The source of power is assumed to be outside of the study area			
Demographic/Community				
Labor Market	Few differences from those under the corresponding Proposed Action alternatives at 100 MW of replacement power. Differences more substantial as replacement power increases. Jobs would contribute to lower unemployment in the region. Effects of 2-Unit Operation would be lower than those for the 3-Unit Operation and also would be lower as level of replacement power increases. Peak jobs would be approximately 1 percent of the combined 3-county employment in 2013, but much higher percentage of jobs held by Navajo and Hopi.			
Population	Little appreciable differences from the effects under the corresponding Proposed Action alternatives at 100 MW of replacement power. Fewer jobs under 2-Unit Operation could result in population declines in Page and some Navajo Chapters. Likelihood of population declines increases at higher quantities of replacement energy, particularly with 2-Unit Operation. Temporary influxes would occur in conjunction with overhauls and selective catalytic reduction installation.			
Housing	Few differences from those under the corresponding Proposed Action alternatives at 100 MW of replacement power.			

Table 3.18-48 Socioeconomic Impacts of the Natural Gas PFR Alternative Related to NGS under the Natural Gas PFR Alternative

Parameter	NGS Configuration and Replacement Power			
	3-Unit Operation		2-Unit Operation	
	100-MW	250-MW	100-MW	250-MW
Effects on public facilities and services	Demands and utilization would continue consistent with historical operations through 2019, with declines in Page and nearby Navajo Chapters under 2-Unit 250-MW.			
Social				
Economic importance for the Navajo Nation and Hopi Tribe	Effects on Navajo Nation would be accentuated under this alternative as job opportunities for Navajo decline at higher levels of curtailment, compounding the effects associated with retiring one generating unit. The Hopi Tribe would not be directly affected by changes in NGS operations. Effects on employment and economic diversity would occur primarily in the LeChee and Kaibeto Chapters, in Page, and to a lesser extent in Flagstaff and Tuba City/Moenkopi areas.			
Social and economic importance for Coconino and Navajo counties and the City of Page	Social and economic effects on nearby off-reservation communities would be accentuated under this alternative due to larger reductions in jobs and income.			
Transition to renewable energy or natural gas	Navajo, Hopi, and NGOs advocating for a transition away from coal may be encouraged with this alternative, particularly as the amount of replacement power rises, but would remain dissatisfied with continued NGS operations. Dissatisfaction under 2-Unit 250-MW Option may be diminished because it would reduce coal as energy source for as much as 46 percent of the federal energy.			
NGS-related air quality, human health and safety, and ecological health concerns	Continued operations of 3 units would result in continued concerns about environmental and health effects of emissions, reduced somewhat by installation of selective catalytic reduction and partial replacement with natural gas. Concerns may be tempered by shutdown of one unit and substantial use of natural gas for replacement power.			

[1] Assumes the NGS participants choose to not adjust the rated capacity of the NGS generating units based on the long-term curtailment. Lowering the rated capacity could reduce the additional payments made to the Navajo Nation.

Substantive socioeconomic differences in the region associated with BM&LP Railroad with implementation of the Natural Gas PFR Alternative would be limited, as compared to those under the Proposed Action. Under this alternative the number of weekly train movements would range between 20.1 round-trips (3-Unit 100 MW) and 11.7 round-trips (2-Unit 250 MW), the latter an average of 1.7 round-trips per day compared to 3.0 trips under historical operation. The lower frequency associated with the Natural Gas PFR 250-MW 2-Unit Operation could result in elimination of 7 day/week operations. Implementation of this alternative would result between 6 and 57 fewer jobs and as much as $4.1 million less annual labor income in the primary segment of the study area. The differences in labor income during the 25-years of extended operations would result in lower retirement income beyond 2044.

3.18.4.4.2 Proposed Kayenta Mine Complex

- Reductions in annual coal production would reduce the company's labor force requirements and royalty and bonus payments made to the Navajo and Hopi tribes (see **Table 3.18-49**). Among all action alternatives, implementation of the Natural Gas PFR Alternative in combination with a 2-Unit configuration would result in the most pronounced changes in local socioeconomic conditions, with the exception of those resulting under No Action.

- Net reductions of as many as 709 jobs in the primary segment of the study area economy would occur. Reductions in employment would range from 5 percent to 42 percent as compared to the Proposed Action 3-Unit Operation.
- Implementation of Natural Gas PFR Alternative in conjunction with a 2-Unit Operation would support between $2.64 billion and $1.57 billion in labor income over the 25 years. However, that total would be as much as $1.2 billion less than under the Proposed Action.
- Extending the operating life of the mine would allow more workers to accrue retirement income benefits that would be realized beyond 2044.
- Over the 25-year period of extended operations, royalty, bonus and water payments would total between $649.1 million and $1.14 billion. Distribution of those revenues would be approximately 67 percent to the Navajo Nation and 33 percent to the Hopi Tribe.
- Over the life of the mine, PWCC payments into the federal Abandoned Mine Land and Black Lung Disability funds would be as much as $23 million less than under Proposed Action 3-Unit Operation.
- The Hopi Tribe would remain heavily reliant on those revenues to support tribal government and to provide essential services for its members living on the reservation.
- Navajo County and the local school district would receive lower property taxes paid by PWCC and from TPT proceeds as compared to Proposed Action 3-Unit Operation.
- Even with the lower levels of coal production and mining activity associated with this alternative under a 2-Unit NGS Option, concerns about air quality, human health and safety, ecological health, and water quality and quantity effects would likely continue.
- Groundwater concerns related to potential depletion of the N-Aquifer would be reduced, but likely persist.
- Residents within and near the lease area would likely continue to be concerned about equity under all PFR alternatives under a 2-Unit NGS Option.
- Under a 2-Unit 250-MW alternative, the surface mining effects on the physical and cultural setting and quality of life in and near the lease area would be substantially less than Proposed Action 3-Unit Operation. However dissatisfaction may persist among residents who value the traditional setting over employment opportunities and PWCC-provided coal, water, firewood and services.

Table 3.18-49 Socioeconomic Impacts of the Natural Gas PFR Alternative Related to the Proposed KMC

	NGS and Replacement Power Configuration			
	3-Unit Operation		2-Unit Operation	
Parameter	100-MW	250-MW	100-MW	250-MW
Operational				
Annual Coal Production (million tons)	7.7	7.1	5.1	4.5
Employment (direct, indirect, and induced) – Typical Year	1,573 75 fewer than Proposed Action 3-Unit Operation	1,453 195 fewer than Proposed Action 3-Unit Operation	1,052 77 fewer than Proposed Action 2-Unit Operation	939 190 fewer than Proposed Action 2-Unit Operation
Aggregate job-years – 2020 to 2044	39,325	36,325	26,300	23,475

Table 3.18-49 Socioeconomic Impacts of the Natural Gas PFR Alternative Related to the Proposed KMC

Parameter	NGS and Replacement Power Configuration			
	3-Unit Operation		2-Unit Operation	
	100-MW	250-MW	100-MW	250-MW
Labor Income / Public Revenue				
Annual Labor Income	$105.6 million	$97.6 million	$70.4 million	$62.7 million
Total Labor Income: 2020 to 2044	$2,639 million	$2,440 million	$1,760 million	$1,567 million
Total lease, royalty, bonus and water payments: 2020 to 2044	$1,137 million	$1,050 million	$764 million	$682 million
Total Property Taxes 2020 to 2044	$33 million	$33 million	$28 million	$28 million
Federal Abandoned Mine Land and Black Lung Disability funds 2020 to 2044	$167 million	$154 million	$111 million	$98 million

3.18.4.4.3 Transmission Systems and Communication Sites

When compared to the Proposed Action scenarios, implementation of a Natural Gas PFR Alternative would result in no substantive socioeconomic consequences related to the existing transmission lines and communication sites. The physical infrastructure is in place, no new construction is proposed, and operations and maintenance would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

3.18.4.4.4 Central Arizona Project

This subsection examines the prospective change in pumping energy costs for the CAP and the effects on water rates that would be associated with the Natural Gas PFR alternatives in a similar fashion as for the Proposed Action (Section 3.13.4.3, Central Arizona Project, and **Technical Supplement 3.18-A**). The analysis of future energy costs to CAP is a weighted average of: (1) future costs of NGS, (2) the incremental costs associated with curtailing NGS production, and (3) the cost of energy purchased from a Natural Gas generating source. The latter are based on NREL's annual baseline series of energy projections, analysis of energy pricing at the Mead hub, and long-term energy pricing projections from the EIA.

Table 3.18-50 presents the energy supply assumptions for this analysis, outlining the total annual power and energy supplied to CAP by NGS, acquired from alternative sources, and the federal share of power generated by NGS that would be available to sell as surplus. Not shown, but included in subsequent energy cost estimates, is 300,000 MW hours of energy assumed to be purchased by CAWCD from Reclamation (Hoover Dam) and other sources. A range of costs associated with future power purchases is presented including costs for construction of a new generation facility for comparative purposes only. Note that new construction was determined to not be economically viable (**Appendix 2A**).

Table 3.18-50 Annual Federal Power from NGS and Natural Gas PFR Alternative Supply for CAP

NGS / PFR Configuration	NGS Supplied to CAP (MW hours)	NGS Available for Surplus (MW hours)	Total NGS Generated (MW hours)	PFR Supplied Power to CAP (MW hours)
Proposed Action 3-Unit Operation	2,696,000	1,472,000	4,168,000	NA
3-Unit/Natural Gas 100 MW	1,819,000	1,472,000	3,290,000	877,000
3-Unit/Natural Gas 250 MW	505,000	1,472,000	1,975,000	2,192,500
Proposed Action 2-Unit Operation	2,696,000	1,421,000	4,117,000	NA
2-Unit/Natural Gas 100 MW	1,819,000	1,421,000	3,240,000	877,000
2-Unit/Natural Gas 250 MW	505,000	1,421,000	1,926,000	2,192,500

Note: CAP is assumed to use an additional 300,000 MW hours of energy per year from other sources.

3.18.4.4.4.1 Future Costs for Energy

Future costs of NGS energy for the Natural Gas PFR are based on the same underlying assumptions outlined under the Proposed Action. However, the incremental costs associated with Lease Amendment No. 1 and selective catalytic reduction are reallocated based on lower annual NGS output; in effect raising the cost of Reclamation energy.[28] The effect on Reclamation's cost of NGS energy would be in direct proportion to the amount of energy sourced from a non-NGS sources. Additionally, Reclamation's costs would be affected by curtailment. Costs for the other participants would likely be unaffected.

The operating agreements for NGS allow a participant to request that its share of power output be curtailed, i.e., not produced. When curtailment occurs, variable operating costs are reduced. However, certain fixed costs would still be incurred and must be covered by the remaining production. Given the projected levels of curtailment for the Natural Gas PFR, such charges are estimated at between $12,278,000 and $30,695,000 per year (**Table 3.18-51**). The incremental costs increase as the amount of replacement energy and hence, the amount of curtailment increases. Thus, the incremental costs associated with Natural Gas PFR 250 MW under the 2-Unit Operation would be substantially higher than those for 100 MW with the 3-Unit Operation.

Table 3.18-51 Incremental Costs to Reclamation due to NGS Curtailment under the Natural Gas PFR Alternative

NGS / PFR Configuration	Annual Curtailment Charges	Annual Curtailment Cost / MW hours
3-Unit/Natural Gas 100 MW	$12,278,000	$3.70
3-Unit/Natural Gas 250 MW	$30,695,000	$15.50
2-Unit/Natural Gas 100 MW	$12,278,000	$3.80
2-Unit/Natural Gas 250 MW	$30,695,000	$15.90

[28] It is assumed for this assessment that reductions in future emissions under the Natural Gas PFR alternative would not affect the timing of selective catalytic reduction installation as compared to the Proposed Action.

3.18.4.4.4.2 Future Energy Costs for CAP

Reclamation's future energy costs under the Natural Gas PFR alternatives, rounded to the nearest $0.10, are shown in **Table 3.18-52**. As shown, energy rates under Natural Gas PFR alternatives could be lower or higher than those under the Proposed Action, depending on the future prices of natural gas. Energy costs could be as much as $4.80 per MW hours lower (2-Unit Operation and 250 MW in 2030 to 2044) or as much as $14.50 per MW hours higher (3-Unit Operation and 250 MW in 2030 to 2044). In other words, the natural gas pricing range projected by NREL indicates a exposure risk to future rates that would be substantially higher than the rates under the Proposed Action than the potential savings associated with lower gas costs.

Table 3.18-52 Future Energy Charges per MW hour under the Natural Gas PFR Alternative

	CAP Annual Energy Charges / MW hours		
NGS / PFR Configuration	**2020 to 2025**	**2026 to 2029**	**2030 to 2044**
Proposed Action 3-Unit Operation	$47.20	$53.00	$54.40
3-Unit/Natural Gas 100 MW Power purchases (range)	$47.80 - $48.50	$53.20 - $54.70	$55.40 - $57.90
3-Unit/Natural Gas 250 MW Power purchases (range)	$45.10 - $57.60	$49.50 - $62.50	$52.80 - $68.90
Proposed Action 2-Unit Operation	$49.40	$50.80	$57.50
2-Unit/Natural Gas 100 MW Power purchases (range)	$49.40 - $54.40	$51.20 - $56.40	$57.70 - $64.20
2-Unit/Natural Gas 250 MW Power purchases (range)	$45.00 - $57.50	$47.50 - $60.50	$52.70 - $68.70

3.18.4.4.4.3 Annual Pumping Energy Costs

Annual energy costs for the Natural Gas PFR Alternative with a 3-Unit Operation would range from $122.4 million to $180.1 million and between $122.1 million and $179.6 million if implemented as part of a 2-Unit Operation (**Table 3.18-53**). The lower and upper ends of those ranges are driven by the low and high range of assumed natural gas prices.

Table 3.18-53 Annual Energy Charges to CAP under the Natural Gas PFR Alternative

	Total Annual Energy Charges [1]			Aggregate Total 2020 to 2044
NGS / PFR Configuration	**2020 to 2025**	**2026 to 2029**	**2030 to 2044**	
Proposed Action 3-Unit Operation	$127,250,000	$141,540,000	$144,780,000	$3,501,000,000
3-Unit/Natural Gas 100 MW Power purchases (range)	$128,870,000 to $130,490,000	$141,810,000 to $145,580,000	$147,200,000 to $153,400,000	$3,548,000,000 to $3,666,000,000
3-Unit/Natural Gas 250 MW Power purchases (`range)	$122,400,000 to $152,590,000	$132,910,000 to $164,460,000	$141,000,000 to $180,090,000	$3,381,000,000 to $4,275,000,000

Table 3.18-53 Annual Energy Charges to CAP under the Natural Gas PFR Alternative

NGS / PFR Configuration	Total Annual Energy Charges [1]			Aggregate Total 2020 to 2044
	2020 to 2025	2026 to 2029	2030 to 2044	
Proposed Action 2-Unit Operation	$132,640,000	$136,150,000	$152,320,000	$3,625,000,000
2-Unit/Natural Gas 100 MW Power purchases (range)	$132,640,000 to $144,780,000	$126,960,000 to $149,630,000	$152,860,000 to $168,500,000	$3,637,000,000 to $3,995,000,000
2-Unit/Natural Gas 250 MW Power purchases (range)	$122,130,000 to $152,320,000	$128,060,000 to $159,600,000	$140,730,000 to $179,550,000	$3,356,000,000 to $4,246,000,000

[1] The annual charges include $14.3 million for the purchases of energy from Hoover and other non-NGS sources. The costs and availability of such power is assumed to be the same under all action alternatives.

The annual energy charges to CAP for the 2030 to 2044 time period, for the Natural Gas PFR alternatives are shown in **Figure 3.18-10**.

Over the 25-year extended operating life of the NGS the aggregate energy costs to the CAP under the Natural Gas PFR alternative would be between $120 million lower and $774 million higher than for the Proposed Action 3-Unit Operation, again reflecting the potential effects of natural gas prices. The differences in aggregate energy costs if implemented with a 2-Unit Operation would be between $269 million lower and $621 million higher, contingent on future natural gas prices.

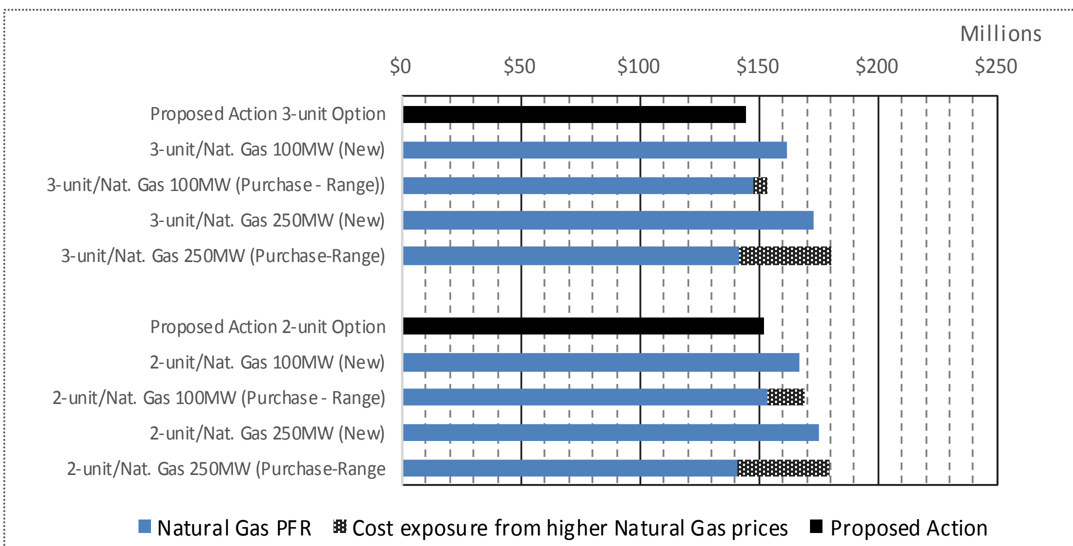

Figure 3.18-10 Annual CAP Energy Costs under the Natural Gas PFR Alternative, 2030 to 2044

Projected annual energy costs under the Natural Gas PFR Alternative, on a per acre-foot of water pumped basis, range between a low of $77 during the 2020 to 2025 period, to as high as $113 during the 2030 to 2044 period (**Table 3.18-54**). Energy costs assuming purchases from existing plant could be lower than the Proposed Action if natural gas prices remain low, but would exceed those of the Proposed Action if natural gas prices rise. The differences reflect the effects of curtailing NGS output on a 24-hour basis and the potential impacts of higher natural gas prices.

Table 3.18-54 CAP Annual Energy Charges per acre-foot under the Natural Gas PFR Alternative

NGS / PFR Configuration	Annual Energy Charges / Acre-Foot [1,2]			
	2020 to 2025	2026 to 2029	2030 to 2044	Net Change 2020 to 2044 (across the row)
Proposed Action 3-Unit Operation	$80	$88	$90	$10
3-Unit/Natural Gas 100 MW Power purchases (range)	$81 to $82	$89 to $91	$92 to $96	Up to $15
3-Unit/Natural Gas 250 MW Power purchases (range)	$77 to $95	$83 to $105	$88 to $113	Up to $36
Proposed Action 2-Unit Operation	$83	$85	$95	$12
2-Unit/Natural Gas 100 MW Power purchases (range)	$83 to $91	$86 to $94	$96 to $105	Up to $32
2-Unit/Natural Gas 250 MW Power purchases (range)	$76 to $95	$80 to $100	$88 to $112	Up to $36

1 Based on 1,600,000 acre-feet per year.

2 Equivalent current rate is approximately $76 / acre-feet (CAWCD 2015a).

The relative impact of the per acre-foot energy costs differences varies over time and between the major customer groups, based on the configuration of NGS and assumed level of replacement energy. For example, during the 2020 to 2025 period, the incremental cost of pumping energy under a 2-Unit configuration with the use of 250 MW of replacement power, ranges from -$7 to $11 per acre foot. In relative terms that range of increase would represent increases of between 9 percent lower and 14 percent higher (**Table 3.18-55**).

Table 3.18-55 Comparative Impact of Energy Charges for CAP Customers, 2020 to 2025

	Total Annual Energy Charges			
	M&I Long-term Subcontract	M&I Non-subcontract and Recharge	Federal	Agricultural Settlement Pool
Firm 2016 Rate per Acre-Foot	$161	$184	$161	$76
$7 decrease as a percent of 2016 firm rate	-4%	-4%	-4%	-9%
$11 increase as a percent of 2016 firm rate	7%	6%	7%	14%

As under the Proposed Action, customers in the Agricultural Settlement Pool and tribal agricultural producers that use water for irrigation would be most heavily affected in relative terms because increases in production costs typically come from the “bottom line” (i.e., lower farm income). Agricultural use of water represents approximately 25 to 30 percent of the annual water deliveries by CAP. Higher production costs and lower income may result in farming operations being scaled back, changes in cropping patterns or the amount of land in production, or in some instances, could result in cessation of farming. Other potential effects described above for the Proposed Action, for instance, reductions in employment, and additional groundwater pumping, also could result with higher under the Natural Gas PFR alternatives. Any future increases in CAP's fixed O&M rates would compound the effects of higher pumping energy costs for customers other than those in the Agricultural Settlement Pool.

As with the Proposed Action, higher energy rates could hamper CAP-affected tribes plans to support future agricultural and development uses and population growth, and their ability to reestablish traditional irrigation-based agriculture on their reservations. CAP-affected tribes also would have fewer revenues to fund tribal services. These effects would be higher than those described for the Proposed Action under the Natural Gas PFR Alternative.

The energy rates (**Table 3.18-55**) costs associated with the Natural Gas PFR Alternative could affect the economic feasibility of surplus energy sales, both in terms of the likelihood and value of such energy sales. The incremental costs and thus, the risk to surplus sales, change in response to the levels of replacement energy and curtailment and changes in natural gas prices. Continued low natural gas prices could offer lower rates and result in savings to CAP. Conversely, higher natural gas prices would raise Reclamation's energy costs, further undermining the likelihood for surplus energy sales and surplus revenues. Conceivably, the loss of surplus revenue sales and impacts of curtailment costs associated with higher levels of replacement energy could raise costs to the point that would render Reclamation's energy costs economically unjustifiable for CAP.

Reductions or the total elimination of such revenues due to the high cost of energy represents a financial risk to CAP's customers as lower surplus reduce revenues into the Development Fund. Compensating for such reductions would require adjustments by CAP to fund debt service. Other resources available to CAWCD for debt service include the capital charges assessed to M&I customers, reserves, and ad valorem/property taxes. CAWCD currently imposes the maximum permissible rate for the latter.

Higher energy costs would require correspondingly reductions in consumer, business, and government expenditures for other goods and services, some of which would occur within the region, but others would affect non-local expenditures. The reductions would be long-term, increasing following selective catalytic reduction installation. Beyond those indirect economic impacts attributable to the lower consumer expenditures, further secondary impacts would occur if the outlays for replacement energy leave Arizona.

3.18.4.4.5 Project Impact Summary – All Project Components

Approving an extended operational life of the NGS and proposed KMC, in conjunction with the partial replacement of the federal share of NGS energy with purchased energy generated by lower-emitting source(s) fired by natural gas, would have far-reaching socioeconomic consequences for northeastern Arizona, and in particular the Navajo Nation, Hopi Tribe and many individual members of the two tribes. The impacts of this Natural Gas PFR, assuming replacement of between 100 MW and 250 MW of energy from NGS, would extend to the CAP-affected tribes and other CAP customers, affecting the future cost of pumping energy and the prospects for future sales of surplus energy yielding revenues to support the Development Fund. **Table 3.18-56** summarizes the critical socioeconomic effects associated with the Natural Gas PFR alternatives.

Table 3.18-56 Socioeconomic Impact Summary for the Natural Gas PFR Alternative

	NGS Configuration And Replacement Power			
	3-Unit Operation		2-Unit Operation	
	100-MW	250-MW	100-MW	250-MW
Operations				
Federal Energy from NGS (TW hours/year)	3.29	1.98	3.24	1.93
Coal Used (million tons) Annual Aggregate 2020 to 2044	 7.7 193	 7.1 178	 5.1 128	 4.5 138
Employment				
New Regional Jobs Tied to Alternative Power	0	0	0	0
Total Regional Jobs – Typical Year	3,650	3,452	2,587	2,392
Aggregate total job-years – 2020 to 2044	91,250 4% less than Proposed Action 3-Unit	86,300 9% less than Proposed Action 3-Unit	64,675 6% less than Proposed Action 2-Unit	59,800 10% less than Proposed Action 2-Unit
Labor Income and Public Revenue				
Annual Labor Income	$248.2 million	$231.1 million	$175.8 million	$159.2 million
Aggregate Labor Income: 2020 to 2044	$6,205 million	$5,779 million	$4,394 million	$3,979 million
Access to fringe benefit programs and long-term retirement income	Access to benefits and retirement income extended for current and a future generation of workers. Fewer workers would benefit than under the respective Proposed Action operation; the differences increasing with higher levels of replacement.			
Aggregate lease and other payments to the Navajo Nation, Hopi Tribe, local governments and public education: 2020 to 2044	$2,499 million	$2,416 million	$1,742 million	$1,659 million
Net revenue effects to the Navajo Nation and Hopi Tribe as compared to end of 2019	Navajo Nation – much higher Hopi – somewhat lower	Navajo Nation – much higher Hopi - lower	Navajo Nation – higher Hopi – much lower	Navajo Nation – higher Hopi – much lower
Demographic/Community				
Air quality, human health and safety, ecological health, water quantity and quality, and elements of traditional lifestyles and social stability.	Public concerns under the Natural Gas PFR Alternative would be similar to those identified for the Proposed Action operations. The extent to which public concerns would be sensitive to changes in outputs associated with the Natural Gas PFR Alternative, particularly levels of mining, is unknown. Effects on economic and community stability, NGS and PWCC support for educational and community charitable causes would be similar to, but proportionally less compared to the respective Proposed Action operation. Implementation of this alternative, with higher levels of replacement energy, may result in some emigration from the region because of lower employment. These effects would translate to effects on local housing and community services. Concerns about the effects of NGS emissions and KMC emissions, dust and related effects would persist, but may be tempered somewhat at higher rates of replacement energy.			

Table 3.18-56 Socioeconomic Impact Summary for the Natural Gas PFR Alternative

	NGS Configuration And Replacement Power			
	3-Unit Operation		2-Unit Operation	
	100-MW	250-MW	100-MW	250-MW
	Navajo, Hopi, and NGOs advocating for a transition from coal-fired generation to lower-emissions sources would be dissatisfied with the continued operations of NGS. Concerns for potential effects on groundwater and surface water would be the same as under the Proposed Action. PWCC community support programs that benefit residents of the proposed KMC area, and nearby Navajo chapters and Hopi villages would continue. Lower coal requirements may result in fewer future household relocations and withdrawal of grazing lands in the proposed KMC lease area, particularly under the 2-Unit Operation and high levels of replacement energy. Effects of surface mining on the physical and cultural setting and quality of life in and near the lease area would be somewhat lower than under the corresponding Proposed Action operations. Future KMC operations would perpetuate dissatisfaction among local residents who value the traditional setting over job opportunities, mine-related revenues which support tribal government and services, and PWCC-provided services. Support of local economic and community stability would be stronger under the 3-Unit Operation than under the 2-Unit Operation and stronger at lower levels of replacement energy.			
CAP Energy Charges				
Annual 2030 to 2044 (millions)	$147.2 to $153.4	$141.0 to $180.1	$152.9 to $168.5	$140.7 to $179.6
Aggregate Total 2020 to 2044 (millions)	$3,458 to $3,666	$3,381 to $4,275	$3,637 to $3,995	$3,356 to $4,246
Primary reasons for cost differences	Curtailment costs are a primary factor, followed by project natural gas prices, selective catalytic reduction installation and higher lease costs to the Navajo Nation.			

3.18.4.4.6 Summary of Impacts

3.18.4.4.6.1 Regional Employment and Wages for the Navajo Nation and Hopi Tribe

Displacement of energy from NGS under the Natural Gas PFR would support fewer jobs in the region. Nonetheless, the project related impacts on regional employment and wages would be major under either operation. Support for Hopi Tribal government under the 2-Unit Operation and 250 MW of replacement energy would be much lower than that at the end of 2019, and might necessitate cutbacks in employment, programs and services. These impacts would be important because of the persistent unemployment and poverty in the region.

3.18.4.4.6.2 Demographic, Economic, Attitudes, and Social Organization Trends on Navajo and Hopi Populations

Generally, such impacts under the Natural Gas PFR would be similar to those described for the Proposed Action operations. The primary difference would be the potential for some emigration from the region due to lower employment/higher unemployment, particularly under the 2-Unit Operation with higher levels of replacement energy. Emigration could have indirect effects on housing availability and prices and community services. Nonetheless, the incomes and access to fringe benefits, including retirement income, would support community stability among the Navajo and Hopi. Continued operation of the NGS and the proposed KMC would lead to concerns and dissatisfaction among some individual members of the two tribes and some NGOs. These impacts would range from major to moderate.

3.18.4.4.6.3 Lease Fees, Royalties, Water Fees, and Other Payments to the Navajo Nation and Hopi Tribe

Project-related payments to the Navajo Nation and Hopi Tribe account for large portions of their respective general fund revenues to support governmental options, particularly for the Hopi Tribe. Future revenues under the Natural Gas PFR would be higher for the Navajo Nation than those at the end of 2019, but for the Hopi Tribe, future revenues would be lower, particularly under the 2-Unit Operation with 250 MW of replacement energy. Given the magnitude of those revenues and few opportunities to replace reduced revenues with revenues from other sources, the fiscal impacts of implementation of the Natural Gas PFR operation would be major.

3.18.4.4.6.4 Social Fabric and Values that Provide Incentives for Younger Tribal Members to Remain on the Reservation

These impacts would be essentially the same as for the Proposed Action operations; major because of the foreseeable limited availability of foreseeable comparable opportunities and incomes from other employers.

3.18.4.4.6.5 Future Costs of Power Required for CAP Pumps and Economic Impacts Related to Reductions in Surplus Revenues for the Development Fund

Pumping energy costs for the CAP under the Natural Gas PFR Alternative could be as much as 8 percent lower or as much as 22 percent higher than those under the Proposed Action depending on future natural gas prices. The unavoidable costs associated with selective catalytic reduction installation, Lease Amendment No. 1, basic operating costs and costs associated with curtailment would create upward pressure on rates. Those pressures could be offset by low natural gas prices, or exacerbated by rising natural gas prices. In the event of higher energy costs, this alternative could adversely affect revenues from future surplus energy sales to support to the Development Fund, making it economically unjustifiable for CAWCD to purchase energy and power from NGS.

3.18.4.4.7 Cumulative Impacts

The contributions of the NGS and proposed KMC to cumulative effects within the cumulative impact study area, under the Natural Gas PFR would be similar to those described above for the Proposed Action. The primary difference would be that revenues to the Navajo Nation that would provide revenue stability would be lower under this alternative. Nonetheless, the contributions to cumulative effects would be moderate to major.

3.18.4.5 Renewable Partial Federal Replacement Alternative

3.18.4.5.1 Navajo Generating Station

Implementation of the Renewable PFR Alternative assumes NGS output would be curtailed to reduce the federal share of NGS energy by between 100 MW and 250 MW of generating capacity over a 14-hour period, that duration generally corresponding to the period of high commercial and residential demand and the availability of renewable generation capacity in the southwest. A corresponding amount of energy would be supplied by power purchased from non-NGS sources, with a stipulation that the generating source(s) be renewable technology. Generation from two or more sources, possibly involving different technologies, would be required to supply the necessary level of power for the defined duration. For this assessment, it is assumed that the source(s) would already exist. Between 0.51 TW hours and 1.28 TW hours of power and energy would be sourced annually from renewable sources; equivalent to between 58.3 MW hours and 145.8 MW hours per hour over the course of the year.

Energy deliveries from the renewable sources would be monitored over time and curtailment at NGS scheduled to achieve the necessary reduction in NGS production and associated reductions in coal combustion. The curtailment would not necessarily be concurrent with the scheduled delivery of energy from the renewable sources to the CAP, however reductions in the amount of power produced at NGS would occur over a yet-to-be determined period of time, i.e., monthly, quarterly or yearly, to total that supplied by renewable sources. Allowing for non-concurrent curtailment provides flexibility to optimize operations of NGS and also to maximize the potential value of surplus energy sales, while still assuring achievement of the established levels of emission reductions.

Under the Renewable PFR Alternative, replacement energy sourced from the grid would not fully meet the CAP's power needs. NGS generated power would fill the unmet demand, the remainder available for sale to support the Development Fund. Such sales would be contingent upon market conditions and NGS surplus power being cost competitive.

Projected annual energy production at NGS, the allocation of that power between CAP and its availability as surplus, and corresponding annual coal use are shown in **Table 3.18-57**.

Table 3.18-57 Annual Energy Output and Coal Use for the Renewable PFR Alternative

NGS Configuration	Proposed Action	Renewable PFR 100 MW Replacement	Renewable PFR 250 MW Replacement
3-Unit Operation, 547-MW Federal Share			
Federal Energy From NGS (TW hours/year) [1]	4.17	3.66	2.89
Federal Energy Supplied to CAP (TW hours/year)	2.70	2.19	1.42
NGS Energy Available as Surplus (TW hours/year)	1.47	1.47	1.47
Annual Tons of Coal Used – NGS Total (million tons) Differences [percentage] [2]	8.1 NA	7.9 - 2%	7.5 - 7%
2-Unit Operation, 540-MW Federal Share			
Federal Energy From NGS (TW hours/year)	4.12	3.61	2.84
Federal Energy Supplied to CAP (TW hours/year)	2.70	2.19	1.42
NGS Energy Available as Surplus (TW hours/year)	1.42	1.42	1.42
Annual Tons of Coal Used – NGS Total (million tons) Differences [percentage] [2]	5.5 NA	5.3 - 4%	4.9 - 11%

[1] TW hours/year = terawatt-hours per year. 1 terawatt equals 1,000,000,000,000 watts.

[2] Differences in tons of coal are relative to the base tonnages for the corresponding 3-Unit Operation or 2-Unit Operation Proposed Action.

NA = not applicable.

Implementation of the Renewable PFR Alternative would reduce annual coal consumption by 0.2 to 0.6 million tons; an amount equivalent to approximately 10 to 30 percent of the coal required for production of the federal share of power from NGS. The coal consumption reduction is proportional to the increase in renewable capacity; For the Proposed Action 2-Unit Operation, the Renewable PFR Alternative reductions would be in addition to those associated with shutting down one unit at NGS.

The implications associated with this alternative related to operational changes at NGS, the BM&LP Railroad, and the proposed KMC are described below. Compared to the Proposed Action, differences in employment, labor income, royalty and bonus income, and rail operations, generally would be proportional to the combined reductions from retirement of one generating unit and associated cutbacks in the amount of federal power and energy supplied by NGS with proportional effects on tonnages of coal mined.

There would be no new jobs, labor income, tax revenues or other economic effects in the primary segment of the study area associated with the Renewable PFR Alternative because these alternatives are assumed to involve power purchases from existing generating sources. To the contrary, long-term curtailment of power and energy generation at NGS could result in cutbacks in NGS staffing and reductions in other operating expenditures. The impetus for such cutbacks would be lower under this alternative than under the Natural Gas PFR Alternative. The socioeconomic effects associated with changes tied to NGS for the Renewable PFR Alternative 3-Unit Operation and 2-Unit Operation configurations are presented in **Table 3.18-58**.

The key differences are the combined effects of retiring one unit and higher levels of curtailment on local employment, income, and the resulting possibility of population outmigration in the Page, Arizona area. On a net basis for the primary segment of the study area, the effects in the Page, Arizona area could be offset by gains in Navajo Nation tribal employment supported by the higher lease and additional payments that also would accrue under this Alternative.

Table 3.18-58 Socioeconomic Impacts of the Renewable PFR Alternative Related to NGS

	NGS Configuration and Replacement Power			
	3-Unit Operation		2-Unit Operation	
Parameter	**100-MW**	**250-MW**	**100-MW**	**250-MW**
Employment				
New Regional Jobs Tied to Alternative Power	0	0	0	0
Total Regional Jobs (direct, indirect, and induced): Typical Year	2,096 68 fewer than Proposed Action 3-Unit Operation	2,054 110 fewer than Proposed Action 3-Unit Operation	1,559 57 fewer than Proposed Action 2-Unit Operation	1,509 107 fewer than Proposed Action 2-Unit Operation
Aggregate job-years: 2020 to 2044	52,410	51,360	38,985	37,25
Labor Income and Public Revenue				
Annual Labor Income	$144.3 million	$139.6 million	$107.9 million	$102.6 million
Aggregate Labor Income: 2020 to 2044	$3,608 million	$3,490 million	$2,698 million	$2,565 million
Total NGS lease and other payments to the Navajo Nation: 2020 to 2044	$ 1,075 million Same as Proposed Action 3-Unit Operation	$ 1,075 million	$ 793 million Same as Proposed Action 2-Unit Operation	$ 793 million
Total property tax and in-lieu payments: 2020 to 2044: Coconino County / Public Education	$ 254.2 million Same as Proposed Action 3-Unit Operation	$ 254.2 million	$ 157.2 million Same as Proposed Action 2-Unit Operation	$ 157.2 million
Additional lease or tax income from PFR Alternative	None. The source of power is assumed to be outside of the study area			
Demographic/Community	No appreciable differences as compared to the corresponding proposed alternative			

Table 3.18-58 Socioeconomic Impacts of the Renewable PFR Alternative Related to NGS

Parameter	NGS Configuration and Replacement Power			
	3-Unit Operation		2-Unit Operation	
	100-MW	250-MW	100-MW	250-MW
Social				
Economic importance for the Navajo Nation and Hopi Tribe	Effects on Navajo Nation would be accentuated under this alternative as job opportunities for Navajo decline at higher levels of curtailment, compounding the effects associated with retiring one generating unit. The Hopi Tribe would not be directly affected by changes in NGS operations. Effects on employment and economic diversity would occur primarily in the Le Chee and Kaibeto Chapters, in Page, and to a lesser extent in Flagstaff and Tuba City/Moenkopi areas.			
Social and economic importance for Coconino and Navajo counties and the City of Page	Social and economic effects on nearby off-reservation communities would be similar to those under the corresponding Proposed Action operations due to comparability in employment, income and tribal revenues under these alternatives.			
Transition to renewable energy or natural gas	Navajo, Hopi, and NGOs advocating for a transition away from coal would remain dissatisfied with continued NGS operations, but may be encouraged with this alternative, particularly as the amount of replacement power rises. Dissatisfaction under 2-Unit Operation with 250-MW reduction may be diminished because it would reduce coal as energy source for as much as 31% of the federal energy.			
NGS-related air quality, human health and safety, and ecological health concerns	Continued operations of 3 units would result in continued concerns about environmental and health effects of emissions, reduced somewhat by installation of selective catalytic reduction and partial replacement with a renewable source. Concerns may be tempered by shutdown of one unit and substantial use of a renewable source for replacement power.			

The Renewable PFR Alternative would result in few discernible socioeconomic consequences related to the BM&LP Railroad in comparison to the Proposed Action. Changes that would occur from a socioeconomic perspective, would be tied to changes in the average weekly number of train trips. Weekly train movements would average between 20.5 round trips and 12.6 round-trips. Implementation of the Renewable PFR Alternative and the curtailment of production at NGS would result in between 4 and 53 fewer rail-related jobs and up to $3.7 million less in annual labor income in the primary segment of the study area. Individuals living in close proximity to the BM&LP ROW would be aware of the reductions in movements, but the general public would have little awareness of the changes in train movement frequency.

3.18.4.5.2 Proposed Kayenta Mine Complex

Approval and implementation of the Renewable PFR Alternative would result in NGS output being curtailed by between 100 MW and 250 MW according to an established schedule. Under the 2-Unit Operation, those reductions in output would be in addition to those stemming from the retirement of one 750-MW generating unit. Reductions in energy generation would reduce coal requirements from the proposed KMC, and consequently the company's labor needs and annual royalty and bonus payments made to the tribes.

Annual coal production under the Renewable PFR Alternative would decline from the 8.1 million tons required to support operation of a 3-Unit Operation under the Proposed Action, to between 7.9 million tons (100 MW) and 7.5 million tons (250 MW). Implementing this PFR Alternative in conjunction with a

2-Unit Operation changes the average annual coal requirement to between 5.3 million tons (100 MW) and 4.9 million tons (250 MW).

Other important socioeconomic impacts that would be tied to the changes in proposed KMC operations under the Renewable PFR Alternative include the following (**Table 3.18-59**):

- As many as 114 fewer jobs in the regional economy as compared to the corresponding Proposed Action operations due to job cutbacks at the mine, losses of secondary jobs supported by those jobs and purchases by PWCC and its vendors, and possible cutbacks in tribal employment tied to reductions in royalty and bonus payments.
- When compared to the corresponding Proposed Action operations, the aggregate employment associated with the proposed KMC, accumulated over 25 years, would be approximately 5,600 fewer job-years under the Natural Gas PFR 3-Unit Operations, with a difference of approximately 4,500 fewer job-years for the Natural Gas PFR 2-Unit Operation.
- Implementation of Renewable PFR Alternative would support between $2.70 billion and $1.70 billion in labor income over the 25 years. There is no reasonably foreseeable new or proposed industrial project or activity in the region that would generate comparable income in primary segment of the study area.
- Extending the operating life of the NGS plant would allow more workers to accrue retirement income benefits that would be realized beyond 2044.
- Annual royalty, bonus and water use payments accruing to the Navajo Nation and Hopi Tribe would be adjusted to reflect production. Over the 25-year period of extended operations such payment would total between $1.19 billion and $772 million. Distribution of those revenues would be approximately 67 percent to the Navajo Nation and 33 percent to the Hopi Tribe.
- The Hopi Tribe would remain heavily reliant on those revenues to support tribal government and to provide essential services for its members living on the reservation.
- Navajo County and the local school district would continue receiving portions of the property taxes paid by PWCC and from TPT proceeds derived from taxable sales in the region, but such receipts would decline in magnitude as compared to the Proposed Action.

Table 3.18-59 Socioeconomic Impacts of the Renewable PFR Alternative Related to the Proposed KMC

Parameter	NGS Configuration and Replacement Power			
	3-Unit Operation		2-Unit Operation	
	100-MW	250-MW	100-MW	250-MW
Operational				
Annual Coal Production (million tons)	7.9	7.5	5.3	4.9
Employment (direct, indirect, and induced) – Typical Year	1,603 45 fewer than Proposed Action 3-Unit Operation	1,534 114 fewer than Proposed Action 3-Unit Operation	1,084 45 fewer than Proposed Action 2-Unit Operation	1,017 112 fewer than Proposed Action 2-Unit Operation
Aggregate job-years: 2020 to 2044	40,075	38,350	27,100	25,425

Table 3.18-59 Socioeconomic Impacts of the Renewable PFR Alternative Related to the Proposed KMC

Parameter	NGS Configuration and Replacement Power			
	3-Unit Operation		2-Unit Operation	
	100-MW	250-MW	100-MW	250-MW
Labor Income and Public Revenue				
Annual Labor Income	$107.8 million	$103.0 million	$72.5 million	$68.1 million
Total Labor Income: 2020 to 2044	$2,695 million	$2,576 million	$1,813 million	$1,703 million
Total lease, royalty, bonus and water payments: 2020 to 2044	$1,160 million	$1,111 million	$787 million	$739 million
Total Property Taxes 2020 to 2044	$33 million	$33 million	$28 million	$28 million
Federal Abandoned Mine Land and Black Lung Disability funds 2020 to 2044	$170 million	$163 million	$114 million	$107 million

3.18.4.5.3 Transmission Systems and Communication Sites

When compared to the Proposed Action scenarios, the socioeconomic consequences of the Renewable PFR alternatives would be the same as those under the Proposed Action. The physical infrastructure is in place, no new construction is proposed, and operations and maintenance would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

3.18.4.5.4 Central Arizona Project

This subsection examines the prospective change in pumping energy costs for the CAP and the effects on water rates that would be associated with the Renewable PFR alternatives in a similar fashion as for the Proposed Action (see Section 3.13.4.3, Central Arizona Project and **Technical Supplement 3.18-A**). The analysis of future energy costs to CAP is a weighted average of: (1) future costs of NGS, (2) the incremental costs associated with curtailing NGS production, and (3) the cost of energy purchased from a Renewable generating source.

Table 3.18-60 presents the energy supply assumptions for the Renewable PFR alternatives. Not shown, but accounted for in subsequent energy cost estimates, is 300,000 MW hours/year of energy assumed to be purchased by CAWCD from Reclamation (Hoover Dam) and other sources.

Table 3.18-60 Annual Federal Power from NGS and Renewable PFR Alternative Supply for CAP

Configuration	NGS Supplied to CAP (MW hours/Year)	NGS Available for Surplus (MW hours/Year)	Total NGS Generated (MW hours/Year)	PFR Supplied Power to CAP (MW hours/Year)
Proposed Action 3-Unit Operation	2,696,000	1,472,000	4,168,000	-
3-Unit/Renewable 100 MW	2,185,000	1,472,000	3,657,000	511,000
3-Unit/Renewable 250 MW	1,418,000	1,472,000	2,890,000	1,278,000

Table 3.18-60 Annual Federal Power from NGS and Renewable PFR Alternative Supply for CAP

Configuration	NGS Supplied to CAP (MW hours/Year)	NGS Available for Surplus (MW hours/Year)	Total NGS Generated (MW hours/Year)	PFR Supplied Power to CAP (MW hours/Year)
Proposed Action 2-Unit Operation	2,696,000	1,421,000	4,117,000	-
2-Unit/Renewable 100 MW	2,185,000	1,421,000	3,606,000	511,000
2-Unit/Renewable 250 MW	1,418,000	1,421,000	2,839,000	1,278,000

Note: CAP is assumed to use an additional 300,000 MW hours of energy per year from other sources.

3.18.4.5.4.1 Future Costs for Energy

Future costs of NGS energy for the Renewable PFR are based on the underlying assumptions outlined under the Proposed Action with the incremental costs associated with Lease Amendment No. 1 and selective catalytic reduction adjusted to allocate those costs based on lower annual NGS output.[29] Reclamation's cost of NGS energy also would be affected by curtailment and the cost of "firming," essentially backup capacity to provide the necessary degree of electrical system reliability. Energy costs for the other participants would likely be unaffected by curtailment or regulation.

<u>Charges Associated with Curtailment</u>

Estimated charges for the levels of curtailment associated with the Renewable PFR, are estimated at between $7,154,000 and $17,892,000 per year, equivalent to between $2.00 and $6.30 a "per MW hours generated" basis (see **Table 3.18-61**). Those charges would be lower than the corresponding costs under the Natural Gas PFR, reflecting the lower quantity of replacement energy provided under the Renewable PFR Alternative.

Table 3.18-61 Incremental Costs to Reclamation due to NGS Curtailment under the Renewable PFR Alternative

NGS / PFR Configuration	Annual Curtailment Charges	Annual Cost per MW hours
3-Unit/Renewable 100 MW	$7,154,000	$2.00
3-Unit/Renewable 250 MW	$17,892,000	$6.20
2-Unit/Renewable 100 MW	$7,154,000	$2.00
2-Unit/Renewable 250 MW	$17,892,000	$6.30

<u>Costs for "Firming" of Renewable Generation</u>

Operation of the CAP requires a high degree of electrical system reliability. As a consequence, use of solar or wind-power would require "firming"[30] as needed." For this assessment, such energy needs are estimated at 6 percent of the annual output provided by renewable sources (NREL 2016). It is assumed

[29] It is assumed that reductions in future emissions under the Renewable PFR alternative would not affect the timing of selective catalytic reduction installation as compared to the Proposed Action.

[30] Firming refers to a secondary source of energy to compensate for the normal variability and irregularity of renewable energy generation (e.g., if part of a solar array is shaded by cloud cover) in order to assure delivery of a specific quantity of energy during a defined period of time. Firming power is typically provided by natural gas fired combined cycle generators.

that the energy would be supplied by a natural gas facility at the same $63.00 per MW hours assumed for replacement energy.

3.18.4.5.4.2 Future Energy Costs for CAP

The CAP's future energy costs under the Renewable PFR alternatives, rounded to the nearest $0.10, are shown in **Table 3.18-62**. As shown, the PFR alternatives would all result in higher costs of energy for CAP, with the differences increasing in magnitude as the level of replacement climbs.

Table 3.18-62 Future Energy Charges per MW hour under the Renewable PFR Alternative

NGS / PFR Configuration	CAP Annual Energy Charges / MW hours		
	2020 to 2025	2026 to 2029	2030 to 2044
Proposed Action 3-Unit Operation	$47.20	$53.00	$54.40
3-Unit/Renewable 100 MW	$52.60	$57.80	$58.60
3-Unit/Renewable 250 MW	$59.80	$63.80	$63.60
Proposed Action 2-Unit Operation	$49.40	$50.80	$57.50
2-Unit/Renewable 100 MW	$54.40	$55.50	$61.20
2-Unit/Renewable 250 MW	$61.10	$61.80	$65.60

3.18.4.5.4.3 Annual Pumping Energy Costs

Annual energy costs under the Renewable PFR Alternative with a 3-Unit Operation would range from $140.4 million to $167.2 million and between $144.7 million and $172.0 million if implemented as part of a 2-Unit Operation (**Table 3.18-63**). The comparative annual energy charges to CAP for the 2030 to 2044 time period, for the Renewable PFR alternatives and the Proposed Action 3-Unit Operation and 2-Unit Operation, are shown in **Figure 3.18-11**.

Table 3.18-63 Annual Energy Charges to CAP under the Renewable PFR Alternative

NGS / PFR Configuration	Total Annual Energy Charges [1]			Aggregate Total 2020 to 2044
	2020 to 2025	2026 to 2029	2030 to 2044	
Proposed Action 3-Unit	$127,250,000	$141,540,000	$144,780,000	$3,501,000,000
3-Unit/Renewable 100 MW	$140,410,000	$153,080,000	$154,960,000	$3,779,000,000
3-Unit/Renewable 250 MW	$157,990,000	$167,690,000	$167,150,000	$4,126,000,000
Proposed Action2-Unit	$132,640,000	$136,150,000	$152,320,000	$3,625,000,000
2-Unit/Renewable 100 MW	$144,720,000	$147,420,000	$161,160,000	$3,875,000,000
2-Unit/Renewable 250 MW	$161,220,000	$162,840,000	$172,000,000	$4,199,000,000

[1] The annual charges include $14.3 million for the purchases of energy from Hoover and other non-NGS sources. The costs and availability of such power is assumed to be the same under all action alternatives

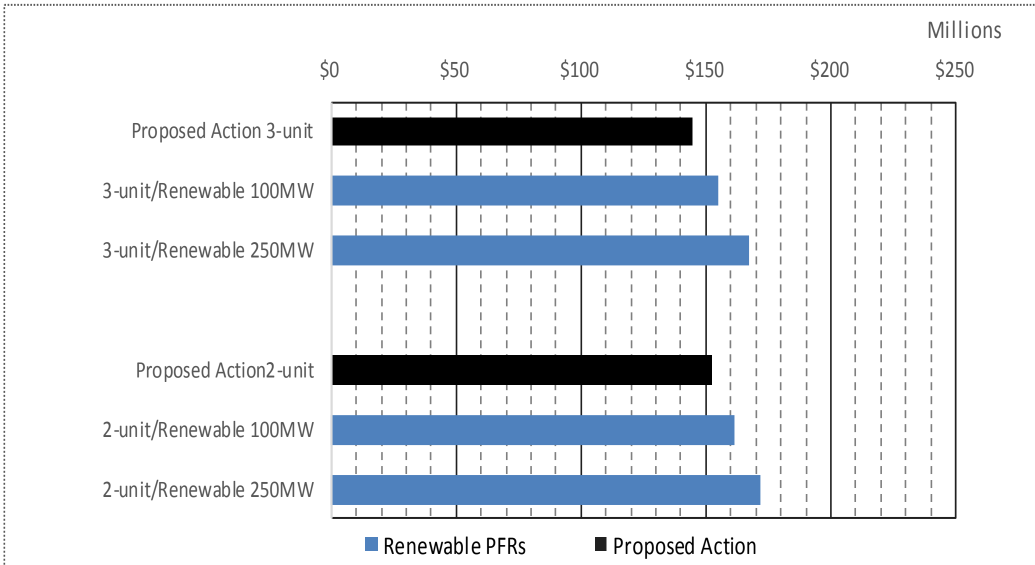

Figure 3.18-11 Annual CAP Energy Costs for the Renewable PFR Alternative, 2030 to 2044

Over the 25-year extended operating life of the NGS the aggregate energy costs to the CAP under the Renewable PFR Alternative would be between $278 million (8 percent) and $625 million (18 percent) higher than for the Proposed Action 3-Unit Operation. The differences in aggregate energy costs if implemented with a 2-Unit Operation would be between $250 million and $574 million.

Projected annual energy costs under the Renewable PFR Alternative, on a per acre-foot of water pumped basis, range from $88 to $101 during the 2020 to 2025 period, $92 to $105 during the 2026 to 2029 period, and $97 to $108 during the 2030 to 2044 period (**Table 3.18-64**). In all instances, projected costs increase as the level of replacement energy increases and would exceed those for the corresponding Proposed Action operation.

Table 3.18-64 CAP Annual Energy Charges per acre-foot under the Renewable PFR Alternative

Configuration	Annual Energy Charges / Acre-Foot [1,2]			
	2020 to 2025	2026 to 2029	2030 to 2044	Net Change 2020 to 2044 (across the row)
Proposed Action 3-Unit Operation	$80	$88	$90	$10
3-Unit/Renewable 100 MW	$88	$96	$97	$9
3-Unit/Renewable 250 MW	$99	$105	$104	$5
Proposed Action 2-Unit Operation	$83	$85	$95	$12
2-Unit/Renewable 100 MW	$90	$92	$101	$11
2-Unit/Renewable 250 MW	$101	$102	$108	$7

[1] Based on 1.6 million acre-feet per year.

[2] Equivalent current rate is approximately $76 / acre-feet (CAWCD 2015a).

The relative impact of the per acre-foot energy costs differences varies over time and between the various groups customers, based on the configuration of NGS and the amount of replacement energy. For example, during the 2020 to 2025 period, the incremental cost of pumping energy under a 2-Unit Operation with the purchase of 250 MW of replacement power, ranges between $7 and $19 per acre foot. In relative terms that range of increase would represent increases of between 4 and 25 percent across the various customers (**Table 3.18-65**). Note that the costs under the Renewable PFR Alternative would be higher than the lower costs under the Natural Gas PFR Alternative (**Table 3.18-51**) but lower than those under the Natural Gas PFR Alternative if natural gas prices were to climb substantially.

Table 3.18-65 Comparative Impact of Energy Charges for CAP Customers, 2020 to 2025, Renewable PFR

Parameter	Total Annual Energy Charges			
	M&I Long-term Subcontract	M&I Non-subcontract and Recharge	Federal	Agricultural Settlement Pool
Firm 2016 Rate per acre-foot	$161	$184	$161	$76
$11 increase as a percent of 2016 firm rate	4%	4%	4%	9%
$24 increase as a percent of 2016 firm rate	12%	10%	12%	25%

As would be true for the Proposed Action and Natural Gas PFR Alternative, customers in the Agricultural Settlement Pool and tribal and other non-tribal agricultural producers using water for irrigation would be most heavily affected.

The energy rate projections (**Tables 3.18-65**) suggest that effects of curtailment on costs associated with the Renewable PFR Alternative could affect future surplus energy sales, with the incremental costs increasing as a function of the levels of replacement energy. Reductions or the total elimination of such revenues due to the high cost of energy represents a financial risk to CAP's customers. Lower sales of surplus would reduce revenues into the Development Fund. Compensating for those reduction venues would require adjustments by CAP to fund debt service. In addition to surplus, other resources available for debt service include the capital charges assessed to M&I customers, reserves, and ad valorem/property taxes. CAWCD currently imposes the maximum permissible rate for the latter.

Higher energy costs for CAWCD would result in corresponding reductions in consumer, business and government expenditures for other goods and services, with associated effects on employment, income and taxes. Some of these indirect effects would occur within the study area; others would occur outside of the study area.

As with the Proposed Action, higher energy rates could hamper CAP-affected tribes' plans to support future agricultural and development uses and population growth, and their ability to reestablish traditional irrigation-based agriculture on their reservations. CAP-affected tribes also would have fewer revenues to fund tribal services. These effects would be higher than those described for the Proposed Action under the Renewable PFR Alternative.

3.18.4.5.5 Project Impact Summary – All Project Components

Approving an extended operational life of the NGS and proposed KMC, in conjunction with the partial replacement of the federal share of energy NGS with energy generated by renewable source(s), would have far-reaching socioeconomic consequences for northeastern Arizona, and in particular the Navajo Nation, Hopi Tribe and many individual members of the two tribes. The impacts of the Renewable PFR, assuming replacement of energy to that which is equivalent to that derived from 100 MW to 250 MW of NGS for a 14-hour period on a 7-day per week basis, would extend to the CAP-affected tribes and other

CAP customers, affecting the future cost of pumping energy and the prospects for future sales of surplus energy yielding revenues to support the Development Fund. **Table 3.18-66** summarizes the critical socioeconomic effects associated with the Renewable PFR Alternative.

Table 3.18-66 Socioeconomic Impact Summary for the Renewable PFR Alternative

	NGS Configuration and Replacement Power			
	3-Unit Operation		2-Unit Operation	
Parameter	**100-MW**	**250-MW**	**100-MW**	**250-MW**
Operational				
Federal Energy from NGS (TW hours/year)	3.66	2.89	3.61	2.84
Coal Used (million tons)				
Annual	7.9	7.7	5.3	4.9
Aggregate 2020 to 2044	198	188	133	123
Employment				
New Regional Jobs Tied to Alternative Power	0	0	0	0
Total Regional Jobs – Typical Year	3,699	3,588	2,643	2,526
Aggregate job-years (direct indirect, and induced) – 2020 to 2044	92,475 3% fewer than Proposed Action 3-Unit Operation	89,700 6% fewer than Proposed Action 3-Unit Operation	66,075 3% fewer than Proposed Action 2-Unit Operation	63,150 6% fewer than Proposed Action 2-Unit Operation
Labor Income and Public Revenue				
Annual Labor Income	$252.1 million	$242.6 million	$180.5 million	$170.7 million
Aggregate Labor Income: 2020 to 2044	$6,433 million	$6,310 million	$4,581 million	$4,461 million
Access to fringe benefit programs and long-term retirement income	Access to benefits and retirement income extended for current and a future generation of workers. Fewer workers would benefit than under the respective Proposed Actions; the differences increasing with higher levels of replacement.			
Aggregate lease and other payments to the Navajo Nation, Hopi Tribe, local governments and public education: 2020 to 2044	$2,532 million	$2,118 million	$1,800 million	$1,803 million
Net revenue effects to the Navajo Nation and Hopi Tribe as compared to end of 2019	Navajo Nation – much higher Hopi – slightly lower	Navajo Nation – much higher Hopi – somewhat lower	Navajo Nation – higher Hopi – much lower	Navajo Nation – higher Hopi – much lower
Demographic/Community				
Air quality, human health and safety, ecological health, water quantity and quality, and elements of traditional lifestyles and community stability.	Public concerns under the Renewable PFR Alternative would be similar to those identified for the Proposed Action operations. The extent to which public concerns would be sensitive to changes in outputs associated with the Renewable PFR Alternative, particularly levels of mining, is unknown. Effects on economic and community stability, NGS and PWCC support for educational and community charitable causes would be similar to, but scaled back slightly as compared to the respective Proposed Action operation. Implementation of this alternative, with higher levels of replacement energy, may			

Table 3.18-66 Socioeconomic Impact Summary for the Renewable PFR Alternative

Parameter	NGS Configuration and Replacement Power			
	3-Unit Operation		2-Unit Operation	
	100-MW	250-MW	100-MW	250-MW
	result in some emigration from the region because of lower employment. These effects would translate to effects on local housing and community services. Concerns about the effects of NGS emissions and KMC emissions, dust and related effects would persist, but may be tempered somewhat under the 2-Unit Operation with higher rates of replacement energy. Navajo, Hopi, and NGOs advocating for a transition from coal-fired generation to lower-emissions sources would be dissatisfied with the continued operations of NGS. Concerns for potential effects on ground and surface water, including depletion and degradation of the N-Aquifer, would be the same as under the Proposed Action. PWCC community support programs that benefit residents of the proposed KMC area, and nearby Navajo chapters and Hopi villages would continue. Lower coal requirements may result in fewer future household relocations and withdrawal of grazing lands in the proposed KMC lease area, particularly under the 2-Unit Operation with high levels of replacement energy. Effects of surface mining on the physical and cultural setting and quality of life in and near the lease area would be somewhat lower than under the corresponding Proposed Action operations. Future KMC operations would perpetuate dissatisfaction among local residents who value the traditional setting over job opportunities, mine-related revenues which support tribal government and services, and PWCC-provided services. Support of local economic and community stability would be stronger under the 3-Unit Operation than under the 2-Unit Operation and at lower levels of replacement energy.			
CAP Energy Charges				
Annual 2030 to 2044 (millions)	$155.0	$167.2	$161.2	$172.0
Aggregate Total 2020 to 2044 (millions)	$3,779	$4,126	$3,875	$4,199
Primary reasons for higher costs	Curtailment and selective catalytic reduction costs are the primary factors, followed by higher lease costs to the Navajo Nation.			

The summary assessment of impacts, as they relate to the specific issues defined in Section 3.18.4.2 above follow.

3.18.4.5.5.1 Regional Employment and Wages for the Navajo Nation and Hopi Tribe

The project-related impacts on regional employment and wages under the Renewable PFR Alternative with 100 MW of curtailment would be essentially the same as those under the Proposed Action 3-Unit Operation. Employment and income under the under the 2-Unit Operation would be lower than the levels expected at the end of 2019. Nonetheless, the project-related impacts on regional employment and wages would be major under either operation. Support for Hopi tribal government under the 2-Unit Operation and 250 MW of replacement energy would be much lower than that at the end of 2019, and might necessitate cutbacks in employment, programs and services. The economic impacts would be major under either operation and important because of the persistent unemployment and poverty in the region.

3.18.4.5.5.2 Demographic, Economic, Attitudes, and Social Organization Trends on Navajo and Hopi Population

Such impacts under the Renewable PFR Alternative would be essentially the same as those described for the Proposed Action operations, and would range from moderate to major.

3.18.4.5.5.3 Lease Fees, Royalties, Water Fees, and Other Payments to the Navajo Nation and Hopi Tribe

Project-related payments to the Navajo Nation and Hopi Tribe account for large portions of their respective general fund revenues to support governmental options, particularly for the Hopi. For the Navajo Nation future revenues under the Renewable PFR would be higher than those at the end of 2019. Future revenues for the Hopi would be lower, particularly under the 2-Unit Operation with 250 MW of replacement energy. Consequently, fiscal impacts of operations under either Proposed Action would be major.

3.18.4.5.5.4 Social Fabric and Values that Provide Incentives for Younger Tribal Members to Remain in their Communities

These impacts would be essentially the same as for the Proposed Action operations; major because of the limited availability of foreseeable comparable opportunities and incomes from other employers.

3.18.4.5.5.5 Future Costs of Power Required for CAP Pumps and Economic Impacts Related to Reductions in Surplus Revenues for the Development Fund

Pumping energy costs for the CAP would increase under either Renewable PFR operation, with energy costs potentially much higher with 250 MW of replacement energy and higher future gas prices. Total pumping energy costs over the 2020 to 2044 time period would increase by between 7 percent (3-Unit Operation with 100 MW PFR) and 18 percent (2-Unit Operation with 250 MW PFR) as compared to those under the Proposed Action. The unavoidable costs associated with selective catalytic reduction installation, Lease Amendment No. 1 (or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1), and basic operating costs would account for a portion of the increase, but costs associated with curtailment and firming would account for the majority of the increases, particularly as the amount of energy provided by the Renewable PFR rises. The likely impacts of those increases would comprise a minor to major impact for users. The higher energy costs under this alternative could adversely affect the economic feasibility of future sales of surplus energy yielding revenues to support to the Development Fund and make it economically unjustifiable for CAWCD to purchase energy and power from NGS.

3.18.4.5.6 Cumulative Impacts

The contributions of the NGS and proposed KMC to cumulative effects within the cumulative impact study area, under the Renewable PFR would be similar to those described above for the Proposed Action. The primary difference would be that revenues to the Navajo Nation that would provide revenue stability would be lower under this alternative. Nonetheless, the contributions to cumulative effects would be moderate to major.

3.18.4.6 Tribal Partial Federal Replacement Alternative

3.18.4.6.1 Navajo Generating Station

Implementation of the Tribal PFR Alternative would involve the purchase of power and energy from photovoltaic solar facility(ies) located on the lands of one or more affected tribes. Energy from the photovoltaic solar facility(ies) would be dedicated to meet a portion of CAP demands during daylight hours (e.g., 12 hours a day), a duration which generally corresponds the period of time that a 100-MW photovoltaic solar facility would be able to reliably meet the 25-MW minimum curtailment requirement for NGS and also deliver 100 MW to 250 MW to the CAP during the midday. The net result would be between 0.33 TW hours and 0.84 TW hours of energy would be sourced from the tribal facility annually with the replacement solar power providing an average of between 38 MW and 94.9 MW hours per hour over the course of a 24-hour period.

Energy deliveries from the photovoltaic system would be monitored over time and curtailment at NGS scheduled to achieve the necessary reduction in NGS production and associated reductions in coal combustion. The curtailment would not necessarily be concurrent with the photovoltaic solar system production; reductions in the amount of power produced at NGS would occur over a yet-to-be determined period of time, i.e., monthly, quarterly or yearly, to total that supplied by the photovoltaic solar facility. Allowing for non-concurrent curtailment provides flexibility to optimize operations of NGS and also maximize the potential value of surplus energy sales, while still assuring achievement of the established levels of emission reductions. Implementation of this PFR alternative would require the solar project to provide firming[31] and the purchased power would be dedicated to supplying a portion of CAP's energy needs.

Under this arrangement, NGS would effectively be run at less than its rated capacity on a long-term basis. The annual projections of energy produced at NGS, the allocation of that power to meet CAP needs, the availability as surplus, and the corresponding projections of annual coal use are shown in **Table 3.18-67**.

Implementation of the Tribal PFR Alternative would reduce annual coal consumption by 0.4 to 0.2 million tons, an amount equivalent to approximately 10 to 20 percent of the coal required for production of the federal share of power from NGS. The coal consumption reduction is proportional to the increase in solar project capacity. For the Proposed Action 2-Unit Operation, the Tribal PFR Alternative reductions would be in addition to those associated with shutting down one unit at NGS.

Table 3.18-67 Annual Energy and Coal Use for the Tribal PFR Alternative

NGS Configuration	Proposed Action	Tribal PFR 100 MW Replacement (Capacity)	Tribal PFR 250 MW Replacement (Capacity)
3-Unit Operation, 547 MW Federal Share			
Federal Energy From NGS (TW hours/year) [1]	4.17	3.84	3.33
Federal Energy Supplied to CAP (TW hours/year)	2.70	2.37	1.86
NGS Energy Available as Surplus (TW hours/year)	1.47	1.47	1.47
Annual Tons of Coal Used – NGS Total (million tons) Differences [percentage] [2]	8.1 NA	7.9 - 2%	7.7 - 5%
2-Unit Operation, 540 MW Federal Share			
Federal Energy From NGS (TW hours/year)	4.12	3.78	3.28
Federal Energy Supplied to CAP (TW	2.70	2.36	1.86

[31] "firming" refers to a secondary source of power to compensate for the normal variability and irregularity of energy generation from a solar facility, i.e., if part of the array is shaded. Renewable sources cannot serve as a "firming" source because they do not offer the necessary reliability and responsiveness.

Table 3.18-67 Annual Energy and Coal Use for the Tribal PFR Alternative

NGS Configuration	Proposed Action	Tribal PFR 100 MW Replacement (Capacity)	Tribal PFR 250 MW Replacement (Capacity)
hours/year)			
NGS Energy Available as Surplus (TW hours/year)	1.42	1.42	1.42
Annual Tons of Coal Used – NGS Total (million tons) Differences [percentage] [2]	5.5 NA	5.3 - 3%	5.1 - 7%

[1] TW hours/year = terawatt-hours per year. 1 terawatt equals 1,000,000,000,000 watts.

[2] Differences in tons of coal are relative to the base tonnages for the corresponding Proposed Action 3-Unit Operation or 2-Unit Operation.

NA = not applicable.

Implementation of the Tribal PFR Alternative would involve construction and operation of a new photovoltaic solar facility on lands of an affected tribe and result in temporary and long-term socioeconomic effects for the affected tribe. The effects include construction and operation jobs, sales revenues for convenience retail and hospitality industry businesses, demand for temporary lodging accommodations including motels, hotels, and recreational vehicles/campgrounds, and increased demand on local facilities and services, particularly law enforcement, emergency medical and other first responders. These effects would be concentrated in the community(ies) near the project location, whether it (they) be on or off-reservation. Some effects would accrue in the community in which the tribal administrative and service agencies are based, if that community is not included in the immediate vicinity of the project location. The temporary effects would last the duration of construction activity; approximately 1.5 years for a facility capable of consistently delivering 100 MW of power to the grid and 2.5 to 3 years for the larger 250-MW facility (**Table 3.18-68**).[32] Construction of the project would support between 533 and 633 temporary jobs and between 9 and 13 long-term jobs.

Construction cost of the photovoltaic solar project ranges are projected at between $300 million (100 MW) and $750 million (250 MW). It is assumed that the project would be located on tribal lands under a long-term lease such that lease costs would be recovered through the revenue derived from energy sales.

The tribe on whose land the new photovoltaic solar facility would be located, would stand to realize lease and/or royalty income from the facility, if the project is owned and operated by an outside developer or a return on capital if the tribe develops the project itself. For this assessment, annual returns of $10,000 per MW are assumed. Consequently the net revenues would range between $1.4 million and $3.5 million. Those returns would accrue to support tribal or chapter services. If located on either the Navajo Nation or Hopi Reservation, revenues from the project would offset some of the reductions in coal royalties. If located on a CAP tribe reservation, such revenues could support tribal operations, or provide revenues to meet future CAP water costs.

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[32] Based on typical photovoltaic solar productivity in northeastern Arizona over the course of a year, delivery of between 100 MW to 250 MW into the grid for transmission to the CAP during the midday would require a system with a nominal capacity of 135 MW to 350 MW. The differences between the 100 MW to 250 MW and the 135 MW to 350 MW specifications account for the effects of seasonal variation, inverter efficiency when converting power produced by the solar array to the form required for the grid, and capacity to meet NGS operational requirements for curtailment (see **Appendix 2A** for additional details).

Table 3.18-68 Economic Characteristics Associated with a New Photovoltaic Solar Facility

Parameter	Tribal Photovoltaic Solar Facility	
	100 MW [2]	250 MW [2]
Construction cost (millions)	~$300	~$750
Duration of construction	1.5 year	2.5 to 3 years
Number of Workers		
Construction	335	400
Indirect and Induced	198	236
Total	533	636
Operations - Total	9	13
Annual Labor Income: operations (millions)	$1.0	$1.4
Annual Lease, Royalty or Property Income (millions) [1]	$1.4	$3.5
Annual Energy Produced (MWh)	333,000	831,000

[1] Assumes lease, royalty or property income of $10,000 per MW of installed capacity.

[2] Delivery of between 100 MW to 250 MW into the grid for transmission to the CAP during the midday would require a system with a nominal capacity of 135 MW to 350 MW.

The key socioeconomic outcomes with respect to the Tribal PFR Alternative include the following (**Table 3.18-69**):

- The Tribal PFR Alternative would result in a combination of temporary construction and long-term operating jobs in conjunction with the photovoltaic solar project. These jobs could add to the gains from increases in tribal and associated indirect and induced jobs funded through the higher lease and additional payments under Lease Amendment No. 1 (or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1).
- The net differences in employment, accumulated over 25 years, would be approximately 2 percent lower under the Tribal PFR Alternative than that for the corresponding Proposed Action operation.
- Implementation of the Tribal PFR Alternative would support substantial labor income in the region, more than $140 million annually with a 3-Unit Operation and more than $93 million annually with a 2-Unit Operation. Both amounts are slightly lower than the corresponding amounts under the Proposed Action.
- Total lease and additional payments of nearly $1.1 billion would accrue to the Navajo Nation between 2020 and 2044 in conjunction with a 3-Unit Operation of NGS. That total represents a 1,300 percent increase above the revenues provided by the current lease.
- Effects on regional labor markets, population, housing, and public facilities and services would be limited under all of these PFR alternatives, due to the limited magnitude of job reductions and the labor availability among the Navajo to fill many if not most of the new positions.
- Extending the operating life of the NGS plant would allow more workers to accrue retirement income benefits that would be realized beyond 2044.

Table 3.18-69 Socioeconomic Impacts of the Tribal PFR Alternative Related to NGS

	NGS Configuration and Replacement Power (Nominal Capacity)			
	3-Unit Operation		2-Unit Operation	
	100-MW	250-MW	100-MW	250-MW
Employment				
Jobs Related to Alt. Power (direct, indirect, and induced) Construction Operating	533 for 1 year 9	636 for 2 years 13	533 for 1 year 9	636 for 2 years 13
Total Regional Jobs (direct, indirect, and induced) – Typical Year	2,125 39 fewer than Proposed 3-Unit Operation	2,113 51 fewer than Proposed 3-Unit Operation	1,586 30 fewer than Proposed 2-Unit Operation	1,568 48 fewer than Proposed 2-Unit Operation
Aggregate job-years – 2020 to 2044	53,135	52,835	35,054	39,210
Labor Income and Public Revenue				
Annual Labor Income	$146.0 million	$143.8 million	$96.1 million	$93.8 million
Aggregate Labor Income: 2020 to 2044	$3,650 million	$3,595 million	$2,740 million	$2,678 million
Total NGS lease and other payments to the Navajo Nation: 2020 to 2044	$ 1,075 million Same as Proposed Action 3-Unit Operation	$ 1,075 million	$ 793 million Same as Proposed Action 2-Unit Operation	$ 793 million
Aggregate property tax and in-lieu payments: 2020 to 2044: Coconino County / Public Education	$ 254.2 million Same as Proposed Action 3-Unit Operation	$ 254.2 million	$ 157.2 million Same as Proposed Action 2-Unit Operation	$ 157.2 million
New lease, royalty or property income from photovoltaic: Annual Total 2020 to 2044	Assumed operational in 2021 $1.4 million $35 million	Assumed operational in 2022 $3.2 million $87.5 million	Assumed operational in 2021 $1.4 million $35 million	Assumed operational in 2022 $3.5 million $87.5 million
Demographic/Community	No appreciable differences as compared to the corresponding proposed alternative			
Social				
Economic importance for the Navajo Nation and Hopi Tribe	Effects on Navajo Nation would be accentuated under this alternative as job opportunities for Navajo decline at higher levels of curtailment, compounding the effects associated with retiring one generating unit. The Hopi Tribe would not be directly affected by changes in NGS operations. Effects on employment and economic diversity would occur primarily in the Le Chee and Kaibeto Chapters, in Page, and to a lesser extent in Flagstaff and Tuba City/Moenkopi areas.			

Table 3.18-69 Socioeconomic Impacts of the Tribal PFR Alternative Related to NGS

	NGS Configuration and Replacement Power (Nominal Capacity)			
	3-Unit Operation		2-Unit Operation	
	100-MW	250-MW	100-MW	250-MW
Social and economic importance for Coconino and Navajo counties and the City of Page	Social and economic effects on nearby off-reservation communities would be similar to those under the corresponding Proposed Action operations due to comparability in employment, income and tribal revenues under these alternatives.			
Transition to renewable energys	Navajo, Hopi, and NGOs advocating for a transition away from coal would remain dissatisfied with continued NGS operations, but may be encouraged with this alternative, particularly as the amount of replacement power rises. Dissatisfaction under 2-Unit 250-MW Operation may be diminished because it would reduce coal as an energy source for as much as 31 percent of the federal energy.			
NGS-related air quality, human health and safety, and ecological health concerns	Continued operations of 3 units would result in continued concerns about environmental and health effects of emissions, reduced somewhat by installation of selective catalytic reduction and partial replacement with a renewable source. Concerns may be tempered by shutdown of one unit and substantial use of a renewable source for replacement power.			

Sociocultural effects associated with operations at NGS under the Tribal PFR Alternative would be similar to those associated with Proposed Action. Changes would stem from the slightly lower NGS employment and from the purchase of energy generated from a tribal renewable source(s) to replace a portion of the federal share of energy generated by NGS. The Tribal PFR Alternative would represent a reduction in total NGS-related employment (direct, indirect, and induced) of approximately 2 to 3 percent as compared to the corresponding Proposed Action operations. These changes include the long-term jobs that would be provided by a 250-MW solar facility, although its location within the primary segment of the study area is uncertain. Reductions in NGS employment would primarily affect the Page, LeChee and Kaibeto communities, and result in moderate reductions in 1) the number of NGS employees available for participation in local government and civic organizations, 2) economic diversity, and 3) a potential reduction in NGS and employee participation in civic, community, and charitable initiatives. As with Proposed Action 3-Unit Operation and Proposed Action 2-Unit Operation, higher NGS lease and other payments could result in an expansion of services and higher employment in Window Rock and elsewhere on the Navajo Nation, if the Nation's allocation of the additional revenue is similar to the current allocation.

The differences that would occur from the Tribal PFR Alternative in conjunction with a Proposed Action 2-Unit Operation are presented in **Table 3.18-46**. In general the effects mirror those for the Proposed Action 3-Unit Operation, but with a few more jobs lost due to curtailment and the resulting possibility of population outmigration in the Page area. On a net basis for the primary segment of the study area, the effects in the Page area could be offset by gains in Navajo Nation tribal employment supported by the higher lease and additional payments that also would accrue under this alternative.

Implementation of the Tribal PFR Alternative would have few discernible socioeconomic consequences related to the BM&LP Railroad in comparison to those effects associated with the Proposed Action. Changes in socioeconomic effects would arise primarily in response to differences in the volume (tonnage) of coal to be transported, which would translate to fewer train movements per day or week. Under this alternative the average number of weekly train movements would be between 12.6 round-trips and 20.5 round-trips. Implementation of this PFR Alternative would result in reductions of between 3 and 46 fewer jobs and a reduction of up to $3.4 million in annual labor income in the primary segment of the study area. No readily discernible fiscal effects to the Navajo Nation, Hopi Tribe, or local governments directly associated with the BM&LP Railroad would result. Individuals living in close proximity to the BM&LP ROW would be aware of the reductions in movements, but the general public would have little awareness of the changes in train movement frequency.

3.18.4.6.2 Proposed Kayenta Mine Complex

Approval and implementation of the Tribal PFR Alternative would result in NGS output being curtailed by between 100 MW and 250 MW on a consistent basis for a pre-established number of hours daily, based on the available output from a new photovoltaic solar project. Under the 2-Unit Operation, those reductions in output would be in addition to those stemming for the retirement of one 750-MW generating unit. Reductions in the quantity of energy generated at NGS would reduce the quantity of coal required from PWCC's proposed KMC, and consequently the company's labor force requirements and annual royalty and bonus payments made to the Navajo and Hopi tribes (**Table 3.18-70**).

Annual coal production under the Tribal PFR Alternative would decline from the 8.1 million tons required to support operation of a Proposed Action 3-Unit Operation at full production, to between 7.9 million tons (100 MW) and 7.7 million tons (250 MW). Implementing the Tribal PFR Alternative in conjunction with a Proposed Action 2-Unit Operation reduces the average annual coal requirement to between 5.3 million tons (100 MW) and 5.1 million tons (250 MW). The latter is equivalent to a 35 percent reduction from the 8.1 million tons required under a full-production 3-Unit Operation. Of the total 3.0 million ton reduction, approximately 0.4 million tons represents the reduction associated with the Tribal PFR Alternative and the remaining 2.6 million tons equals the interests of the other NGS participants associated with retiring one unit.

Other important socioeconomic impacts that would be tied to the changes in the proposed KMC operations under the Tribal PFR Alternative include the following:

- Net reductions of between 30 and 82 jobs in the regional economy as compared to the employment supported by the Proposed Action 3-Unit Operation.
- The net job years, accumulated over 25 years, would be between 1,875 and 17,725 job-years lower as compared to the Proposed Action 3-Unit Operation.
- Implementation of the Tribal PFR Alternative in conjunction with a 3-Unit Operation would support between $2.64 billion and $1.57 billion in labor income over the 25 years.
- Extending the operating life of the mine would allow more workers to accrue retirement income benefits that would be realized beyond 2044.
- Annual lease, royalty, bonus and water sales payments accruing to the Navajo Nation and Hopi Tribe would be adjusted for production. Over the 25-year period of extended operations such payment would total between $1.20 billion and $791 million. Distribution of those revenues would be approximately 67 percent to the Navajo Nation and 33 percent to the Hopi Tribe.
- The Hopi Tribe would remain heavily reliant on those revenues to support tribal government and to provide essential services for its members living on the reservation.
- Navajo County and the local school district would continue receiving portions of the property taxes paid by PWCC and from tax proceeds derived from taxable sales in the region, but such receipts would decline in magnitude.
- Although the combined effects of retiring one unit at NGS and reductions in mining due to replacement power could reduce groundwater pumping, concern regarding the potential depletion of the N-Aquifer would likely continue

Surface mining effects on the physical and cultural setting and quality of life in and near the lease area would be less, but still result in dissatisfaction among residents who value the traditional setting over employment opportunities and PWCC-supplied coal, water, firewood and services.

Table 3.18-70 Socioeconomic Impacts of the Tribal PFR Alternative Related to the Proposed KMC

Parameter	NGS and Replacement Power Configuration (Nominal Capacity)			
	3-Unit Operation		2-Unit Operation	
	100-MW	250-MW	100-MW	250-MW
Operatios				
Annual Coal Production (million tons)	7.9	7.7	5.3	5.1
Employment (direct, indirect, and induced) – Typical Year	1,618 30 fewer than Proposed 3-Unit Operation	1,566 82 fewer than Proposed 3-Unit Operation	1,095 134 fewer than Proposed 2-Unit Operation	1,052 177 fewer than Proposed 2-Unit Operation
Aggregate job-years: 2020 to 2044	40,450	39,150	27,375	26,300
Labor Income and Public Revenue				
Total Labor Income: 2020 to 2044	$2,718 million	$2,630 million	$1,832 million	$1,759 million
Total lease, royalty, bonus and water payments: 2020 to 2044	$1,169 million	$1,135 million	$797 million	$763 million
Total Property Taxes 2020 to 2044	$33 million	$33 million	$28 million	$28 million
Federal Abandoned Mine Land and Black Lung Disability funds 2020 to 2044	$172 million	$167 million	$116 million	$110 million

3.18.4.6.3 Transmission Systems and Communication Sites

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

Implementation of the Tribal PFR Alternative could result in the construction and operation of a new gen-tie line to serve as an interconnection between the solar generating project and the transmission system. Construction and operation of the gen-tie line as part of a solar project, would have limited temporary effects for construction employment, as well as spurring sales for local businesses and taxes for local jurisdictions. Long-term effects of the gen-tie line operation would include employment associated with maintenance and additional lease revenues and/or property taxes. Based on the value of improvements and typical ROW requirements, the magnitude of those effects would be limited. The effects would be the same under either a 3-Unit Operation or 2-Unit Operation, varying slightly based on location and length between the project and the point of interconnection. The same communities that would be affected by construction of the new photovoltaic solar project would likely be affected by any socioeconomic changes related to gen-tie line construction; those communities are unknown at this time.

3.18.4.6.4 Central Arizona Project

This subsection examines the prospective change in pumping energy costs for the CAP and the effects on water rates that would be associated with the Tribal PFR alternatives. The analysis of future energy costs to CAP is a weighted average of: (1) future costs of NGS under the Proposed Action, (2) the incremental costs associated with curtailing NGS production, and (3) the cost of energy purchased from a new solar project developed on lands of the Navajo, Hopi or CAP-affected tribe.

Table 3.18-71 presents the energy supply assumptions for the Tribal PFR Alternative, outlining the annual power and energy supplied to CAP by NGS, acquired from alternative source(s), and the federal share of power generated by NGS that would be available for sale as surplus. Not shown, but accounted for in subsequent energy cost estimates, is 300,000 MW hours of energy assumed to be purchased by CAWCD from Reclamation (Hoover Dam) and other sources.

Table 3.18-71 Annual Federal Power from NGS and Tribal PFR Alternative for CAP

Alternative	NGS Supplied to CAP (MW hours/year)	NGS Available for Surplus (MW hours/year)	Total NGS Generated (MW hours/year)	PFR Supplied Power to CAP (MW hours/year)
Proposed Action 3-Unit Operation	2,696,000	1,472,000	4,168,000	-
3-Unit/Tribal 100 MW	2,362,000	1,472,000	3,834,000	333,000
3-Unit/Tribal 250 MW	1,864,000	1,470,000	3,334,000	831,000
Proposed Action 2-Unit Operation	2,696,000	1,421,000	4,117,000	-
2-Unit/Tribal 100 MW	2,362,000	1,421,000	3,783,000	333,000
2-Unit/Tribal 250 MW	1,862,000	1,421,000	3,283,000	831,000

Note: CAP is assumed to use an additional 300,000 MW hours of energy per year from other sources.

3.18.4.6.4.1 Future Costs for Energy

Future costs of NGS energy for the Tribal PFR Alternative are based on the underlying assumptions outlined under the Proposed Action with the incremental costs associated with Lease Amendment No. 1 and selective catalytic reduction adjusted to allocate those costs based on lower annual NGS output.[33] Reclamation's cost of NGS energy also would be affected by curtailment and the cost of firming. Energy costs for the other NGS co-tenants would likely be unaffected by either curtailment or firming.

Charges Associated with Curtailment

Estimated charges for the levels of curtailment associated with the Tribal PFR Alternative, would be between \$1.30 and \$3.80 on a "per MW hours generated" basis (see **Table 3.18-72**). Those charges would be the lowest among the PFR alternatives, reflecting the lower quantity of replacement energy to be purchased.

Table 3.18-72 Incremental Costs to Reclamation due to NGS Curtailment under the Tribal PFR Alternative

	Annual Charges for Curtailment	Annual Cost per MW hours
3-Unit/Tribal 100 MW	\$4,662,000	\$1.20
3-Unit/Tribal 250 MW	\$11,634,000	\$3.50

[33] It is assumed that reductions in future emissions under the Tribal PFR Alternative would not affect the timing of selective catalytic reduction installation as compared to the Proposed Action.

Table 3.18-72 Incremental Costs to Reclamation due to NGS Curtailment under the Tribal PFR Alternative

	Annual Charges for Curtailment	Annual Cost per MW hours
2-Unit/Tribal 100 MW	$4,662,000	$1.20
2-Unit/Tribal 250 MW	$11,634,000	$3.50

Costs for Regulation of Renewable Generation

Power supplied by a tribal solar facility would require firming. For this assessment, such energy needs are estimated at 6 percent of the annual output provided by renewable sources (NREL 2016). It is assumed that the energy would be supplied by a natural gas facility at the same $63.00 per MW hours assumed for replacement energy.

3.18.4.6.4.2 Future Energy Costs for CAP

The CAP's future energy costs under the Tribal Renewable PFR Alternative, rounded to the nearest $0.10, are shown in **Table 3.18-73**. As shown, the PFR alternatives would all result in higher energy costs, with the differences increasing in magnitude as the level of replacement climbs.

Table 3.18-73 Estimated Future Energy Charges per MW hour for the Tribal PFR Alternative

Alternative	CAP Annual Energy Charges / MW hours		
	2020 to 2025	2026 to 2029	2030 to 2044
Proposed Action 3-Unit	$47.20	$53.00	$54.40
3-Unit/Tribal 100 MW	$50.50	$55.90	$57.10
3-Unit/Tribal 250 MW	$55.10	$59.90	$60.90
Proposed Action 2-Unit	$49.40	$50.80	$57.50
2-Unit/Tribal 100 MW	$52.50	$53.70	$60.00
2-Unit/Tribal 250 MW	$56.60	$57.60	$63.10

3.18.4.6.4.3 Annual Pumping Energy Costs

Annual energy costs for the Tribal PFR Alternative with a 3-Unit Operation would range from $135.3 million to as high as $160.6 million and between $132.6 million and $165.9 million if implemented as part of a 2-Unit Operation (**Table 3.18-74**).

Table 3.18-74 Annual Energy Charges to CAP under the Tribal PFR Alternative

Alternative	Total Annual Energy Charges			Aggregate Total 2020 to 2044
	2020 to 2025	2026 to 2029	2030 to 2044	
Proposed Action 3-Unit	$127,250,000	$141,540,000	$144,780,000	$3,501,000,000
3-Unit/Tribal 100 MW	$135,290,000	$148,490,000	$151,460,000	$3,678,000,000
3-Unit/Tribal 250 MW	$146,610,000	$158,200,000	$160,620,000	$3,922,000,000
Proposed Action 2-Unit	$132,640,000	$136,150,000	$152,320,000	$3,625,000,000
2-Unit/Tribal 100 MW	$140,140,000	$143,100,000	$158,470,000	$3,790,000,000
2-Unit/Tribal 250 MW	$150,000,000	$152,420,000	$165,890,000	$3,998,000,000

The annual energy charges to CAP for the 2030 to 2044 time period, for the Tribal PFR alternatives, are shown in **Figure 3.18-12**.

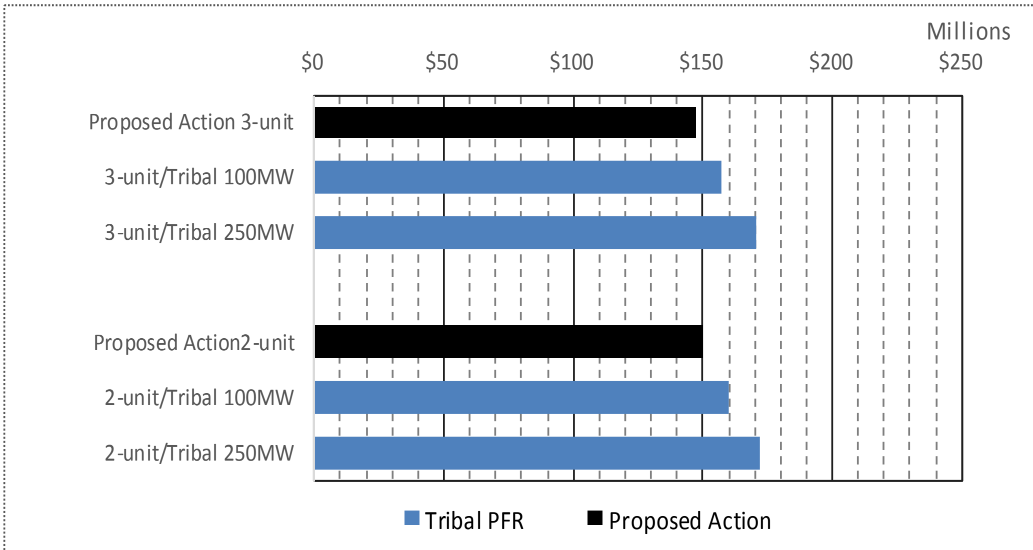

Figure 3.18-12 Annual CAP Energy Costs under the Tribal PFR Alternative, 2030 to 2044

Over the 25-year extended operating life of the NGS the aggregate energy costs to the CAP under the Tribal PFR Alternative would be between $177 million (5 percent) and $421 million (12 percent) higher than for the Proposed Action 3-Unit Operation. The differences in aggregate energy costs if implemented with a 2-Unit Operation would be between $165 million and $373 million.

Projected annual energy costs under the Tribal PFR Alternative, on a per acre-foot of water pumped basis, range from $85 to $94 during the 2020 to 2025 period, $92 to $96 during the 2026 to 2029 period, and $95 to $106 during the 2030 to 2044 period (**Table 3.18-75**). In all instances, projected costs increase as the level of replacement energy increases and would exceed those for the corresponding Proposed Action operation.

Table 3.18-75 CAP Annual Energy Charges per acre-foot under the Tribal PFR Alternative

Configuration	Annual Energy Charges / Acre-Foot [1,2]			
	2020 to 2025	2026 to 2029	2030 to 2044	Net Change 2020 to 2044 (across the row)
Proposed Action 3-Unit Operation	$80	$88	$90	$10
3-Unit/Tribal 100 MW	$85	$93	$95	$10
3-Unit/Tribal 250 MW	$94	$96	$106	$12
Proposed Action 2-Unit Operation	$83	$85	$95	$12
2-Unit/Tribal 100 MW	$90	$92	$101	$11
2-Unit/Tribal 250 MW	$94	$95	$104	$10

[1] Based on 1,600,000 acre-feet per year.

[2] Equivalent current rate is approximately $76 / acre-feet (CAWCD 2015a).

The relative impact of the per acre-foot energy costs differences varies over time and between the various groups of customers, based on the configuration of NGS and the amount of replacement energy. For example, during the 2020 to 2025 period, the incremental cost of pumping energy under a 2-Unit Operation with the purchase of 250 MW of replacement power, ranges between $7 and $11 per acre-foot. In relative terms that range of increase would represent increases of between 4 and 14 percent across the various customers (see **Table 3.18-76**). Note that the costs under the Tribal PFR Alternative would be higher than the lower costs under the Natural Gas PFR Alternative (**Table 3.18-51**) but lower than those under the Natural Gas PFR Alternative if natural gas prices were to climb substantially.

Table 3.18-76 Comparative Impact of Energy Charges for CAP Customers, 2020 to 2025, Tribal PFR Alternative

Parameter	Total Annual Energy Charges			
	M&I Long-term Subcontract	M&I Non-subcontract and Recharge	Federal	Agricultural Settlement Pool
Firm 2016 Rate per acre-foot	$161	$184	$161	$76
$7 increase as a percent of 2016 firm rate	4%	4%	4%	9%
$17 increase as a percent of 2016 firm rate	7%	6%	7%	14%

As would be true for the Proposed Action and the other PFR alternatives, customers in the Agricultural Settlement Pool and tribal and other non-tribal agricultural producers using CAP water for irrigation would be most heavily affected.

The energy rate projections shown in **Tables 3.18-76** suggest that effects of curtailment on costs associated with the Tribal PFR Alternative could contribute to lower future surplus energy sales and revenues, with the incremental costs increasing as a function of the levels of replacement energy. Reductions or the total elimination of such revenues due to the high cost of energy represents a financial risk to CAP's customers. Lower sales of surplus would reduce revenues into the Development Fund. Compensating for those reduction venues would require adjustments by CAP to fund debt service. In addition to surplus, resources available to CAWCD for debt service include the capital charges assessed to M&I customers, reserves, and ad valorem/property taxes. CAWCD currently imposes the maximum permissible rate for the latter.

Higher energy costs for CAWCD would result in correspondingly reductions in consumer, business and government expenditures for other goods and services, with associated effects on employment, income and taxes. Some of these indirect effects would occur within the study area, but occur outside of the study area.

As with the Proposed Action, higher energy rates could hamper CAP-affected tribes' plans to support future agricultural and development uses and population growth, and their ability to reestablish traditional irrigation-based agriculture on their reservations. CAP-affected tribes also would have fewer revenues to fund tribal services. These effects would be higher than those described for the Proposed Action under the Tribal PFR Alternative.

3.18.4.6.5 Project Impact Summary – All Project Components

Approving an extended operational life of the NGS and proposed KMC, in conjunction with the partial replacement of the federal share of energy NGS with energy generated by photovoltaic solar technology located on Navajo, Hopi or CAP-affected tribal land, would have far-reaching socioeconomic consequences for northeastern Arizona, and in particular the Navajo Nation, Hopi Tribe and many individual members of the two tribes. The impacts of the Tribal PFR Alternative, assuming replacement of energy from NGS equivalent to that derived from 100 MW to 250 MW of solar capacity over a 12-hour window on a 7-day per week basis, would extend to the CAP-affected tribes and other CAP customers, affecting the future cost of pumping energy and the prospects for future sales of surplus energy yielding revenues to support the Development Fund. **Table 3.18-77** summarizes the critical socioeconomic effects associated with the Tribal PFR Alternative.

Table 3.18-77 Summary of Socioeconomic Impacts for the Tribal PFR Alternative

Parameter	NGS Configuration And Replacement Power (Nominal Capacity)			
	3-Unit Operation		2-Unit Operation	
	100-MW	250-MW	100-MW	250-MW
Operations				
Federal Energy from NGS (TW hours/year)	3.86	3.38	3.76	3.22
Coal Used (million tons)				
Annual	7.9	7.7	5.3	5.1
Aggregate 2020 to 2044	198	193	133	128
Employment				
New Regional Jobs Tied to Alternative Power				
Construction	533 for 1 year	636 for 2 years	533 for 1 year	636 for 2 years
Operating	9	13	9	13
Total Regional Jobs – Typical Year	3,743	3,679	2,681	2,620
Aggregate job-years: 2020 to 2044	93,575	91,975	67,025	65,500
Labor Income and Public Revenue				
Annual Labor Income (millions)	$256	$250	$184	$179
Aggregate Labor Income: 2020 to 2044 (millions)	$6,490	$6,441	$4,630	$4,594
Access to fringe benefit programs and long-term retirement income	Access to benefits and retirement income extended for current and a future generation of workers. Fewer workers would benefit than under the respective Proposed Actions; the differences increasing with higher levels of replacement.			
Total lease and other payments to the Navajo Nation: 2020 to 2044	$2,532 million	$2,118 million	$1,800 million	$1,803 million
Net revenue effects to the Navajo Nation and Hopi Tribe as compared to end of 2019	Navajo Nation – much higher Hopi – slightly lower	Navajo Nation – much higher Hopi – somewhat lower	Navajo Nation – higher Hopi – much lower	Navajo Nation – higher Hopi – much lower

Table 3.18-77 Summary of Socioeconomic Impacts for the Tribal PFR Alternative

Parameter	NGS Configuration And Replacement Power (Nominal Capacity)			
	3-Unit Operation		2-Unit Operation	
	100-MW	250-MW	100-MW	250-MW
Demographic/Community				
Air quality, human health and safety, ecological health, water quantity and quality, and elements of traditional lifestyles and community stability.	Public concerns under the Tribal PFR Alternative would be similar to those identified for the Proposed Action operations. The extent to which public concerns would be sensitive to changes in outputs associated with the Renewable PFR Alternative, particularly levels of mining, is unknown. Effects on economic and community stability, NGS and PWCC support for educational and community charitable causes would be similar to, but scaled back slightly as compared to the respective Proposed Action operation. Implementation of this alternative, with higher levels of replacement energy, may result in some emigration from the region because of lower employment. These effects would translate to effects on local housing and community services. If a new solar facility were to be built on the Navajo Nation or Hopi Reservation, the short-term and long-term jobs, personal income and income to the tribe could offset some emigration pressures. Concerns about the effects of NGS emissions and KMC emissions, dust and related effects would persist. Navajo, Hopi, and NGOs advocating for a transition from coal-fired generation to lower-emissions sources would be dissatisfied with the continued operations of NGS, but dissatisfaction may be tempered somewhat under the 2-Unit Operation with higher rates of renewable replacement energy, located on tribal lands. Concerns for potential effects on ground and surface water, including depletion and degradation of the N-Aquifer, would be the same as under the Proposed Action. PWCC community support programs that benefit residents of the proposed KMC area, and nearby Navajo chapters and Hopi villages would continue. Lower coal requirements may result in fewer future household relocations and withdrawal of grazing lands in the proposed KMC lease area, particularly under the 2-Unit Operation and high levels of replacement energy. Effects of surface mining on the physical and cultural setting and quality of life in and near the lease area would be somewhat lower than under the corresponding Proposed Action operations. Future KMC operations would perpetuate dissatisfaction among local residents who value the traditional setting over job opportunities, mine-related revenues which support tribal government and services, and PWCC provided services. Support of local economic and community stability would be stronger under the 3-Unit Operation than under the 2-Unit Operation and lower levels of replacement energy.			
CAP Energy Charges:				
Annual: 2030 to 2044 (millions)	$151.5	$160.6	$152.3	$165.9
Aggregate 2020 to 2044 (millions)	$3,678	$3,922	$3,625	$3,998
Primary reasons for higher costs	Curtailment and selective catalytic reduction costs are the primary factors, followed by higher lease costs to the Navajo Nation.			

The summary assessment of impacts, as they relate to the specific issues defined in Section 3.18.4.1 above follow.

3.18.4.6.5.1 Regional Employment and Wages for the Navajo Nation and Hopi Tribe

The project-related impacts on regional employment and wages under the Tribal PFR Alternative would be essentially the same as those under the Proposed Action. Employment and income under the under the 2-Unit Operation would be lower than the levels expected at the end of 2019. Revenue support for Hopi tribal government under the 2-Unit Operation and 250 MW of replacement energy would be much lower than that at the end of 2019, and might necessitate cutbacks in employment, programs and services. The economic impacts would be major under either operation and important because of the persistent unemployment and poverty in the region. Construction of a new solar facility on Navajo Nation or Hopi Reservation would provide new long-term minor to moderate economic stimulus.

3.18.4.6.5.2 Demographic, Economic, Attitudes, and Social Organization Trends on Navajo and Hopi Populations

Such impacts under the Tribal PFR Alternative would be essentially the same as those described for the Proposed Action operations, and range from moderate to major.

3.18.4.6.5.3 Lease Fees, Royalties, Water Fees, and Other Payments to the Navajo Nation and Hopi Tribe

For the Navajo Nation future revenues under the Tribal PFR would be higher than those at the end of 2019, but lower than those associated with the Proposed Action. Future revenues for the Hopi would be lower, particularly under the 2-Unit Operation with 250 MW of replacement energy. Consequently, fiscal impacts of operations under the Tribal PFR Alternative would be major.

3.18.4.6.5.4 Social Fabric and Values that Provide Incentives for Younger Tribal Members to Remain in their Communities

These impacts would be essentially the same as for the respective Proposed Action operations; major because of the foreseeable limited availability of foreseeable comparable opportunities and incomes from other employers.

3.18.4.6.5.5 Future Costs of Power Required for CAP Pumps and Economic Impacts due to Reductions in Surplus Revenues for the Development Fund

Pumping energy costs for the CAP would increase under either Tribal PFR operation, with energy costs potentially much higher with 250 MW of replacement energy and higher future gas prices. Total pumping energy costs over the 2020 to 2044 time period would increase by between 5 percent (3-Unit Operation with 100 MW PFR) and 16 percent (2-Unit Operation with 250 MW PFR) as compared to those under the Proposed Action. The unavoidable costs associated with selective catalytic reduction installation, Lease Amendment No. 1, and basic operating costs would account for a portion of the increase, but costs associated with curtailment and firming would account for the majority of the increases, particularly as the amount of energy provided by the Tribal PFR Alternative rises. The likely impacts of those increases would comprise a minor to major impact for users. The higher energy costs under this alternative could adversely affect the economic feasibility of future sales of surplus energy yielding revenues to support to the Development Fund and economically unjustifiable for CAWCD to purchase energy and power from NGS.

3.18.4.6.6 Cumulative Impacts

The contributions of the NGS and proposed KMC to cumulative effects within the cumulative impact study area, under the Tribal PFR Alternative would be similar to those described above for the Proposed Action. The primary differences would be that revenues to the Navajo Nation that would provide revenue stability would be lower under this alternative and the potential for short and long-term fiscal effects associated with a new photovoltaic solar facility. Nonetheless, the contributions to cumulative effects would be moderate to major.

3.18.4.7 No Action

3.18.4.7.1 Navajo Generating Station and Proposed Kayenta Mine Complex

Because the NGS and the Kayenta Mine are economically interrelated in terms of impacts to employees, and revenues to the Navajo Nation and Hopi Tribe, the consequences of the No Action Alternative implementation are addressed for both components together.

Decisions to withhold approval of the actions that would allow the NGS, proposed KMC, and BM&LP Railroad facilities to operate beyond 2019 would result in actions on the part of the NGS participants and PWCC to take the NGS off-line and complete decommissioning and reclamation required under the existing leases and permits, by the end of 2019. Some of those actions, and the associated socioeconomic effects, would occur prior to the final shutdown. For example, coal mining would cease before the NGS plant ceased operation to facilitate depletion of storage stockpiles at the plant and mine. Overhauls scheduled for 2017, 2018, and 2019 could be modified or cancelled. The effects associated with the post-shutdown activities are not addressed specifically in this assessment as similar activities and effects would occur in the future assuming implementation of the Proposed Action or action alternatives, and are assumed to be of similar type and scale.

Socioeconomic impacts in the primary segment of the study area that would result in conjunction with the No Action Alternative would be major, widespread, and long-lasting. These impacts would directly and indirectly affect the Navajo and Hopi tribal governments, households, businesses and local government agencies and services. Because the NGS and Kayenta Mine are among the largest private sector employers in northeastern Arizona, the effects would extend to Coconino, Navajo and Apache counties and throughout the state. The subsequent loss of existing jobs and income and reductions in revenues paid to the tribes would result in major effects, given persistently high unemployment and poverty among on-reservation Navajo and Hopi, and the importance of the revenues paid to the tribal governments in supporting tribal employment and the provision of services on a reservation-wide basis. The importance of the jobs, income and revenues is underscored by the lack of any identified or reasonably foreseeable new industrial or commercial development that offers prospects to offset the losses.

3.18.4.7.1.1 Local Economic Impacts Associated with Closures

Retiring the NGS at the end of 2019 would precipitate major socioeconomic impacts in the primary segment of the study area which would be regarded as negative by many residents, other local stakeholder interests, and local and tribal governments. The permanent loss of up to 3,090 jobs in the primary segment of the study area would follow in the wake of the shutdown; this would be equivalent to 2.0 percent of the total employment of the entire 3-county region in 2013. Regional labor income would decline by an estimated $261 million per year – see **Table 3.18-78**. The effective losses in jobs and income would be even higher if the prospective gains foregone associated with Lease Amendment No. 1 are considered.

The Navajo Nation and Hopi Tribe are the single largest employers on their respective reservations. They, along with local governments and public education providers, would see combined reductions in net revenues of more than $58.5 million per year; equivalent to more than 23 percent of the combined annual general fund revenues of the two tribes. Foregone revenues to the Navajo under Lease Amendment No. 1 (or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1)would be the equivalent of another 18 percent loss in general fund revenues. The losses would be particularly severe for the Hopi Tribe for which mining-related revenues account for more than 80 percent of its general fund that supports the tribe’s executive, legislative and judicial functions and various services provided to its members. Both Tribes would continue to receive various federal grants and contract funds, and operate their respective enterprise activities, but those grants and contract funds are generally dedicated to sustaining the enterprises and providing specific programs, e.g., housing, and consequently, are unavailable to meet general government expenses.

Local economic and social implications of the effects of No Action would be most heavily felt in Page, Kayenta, the Navajo chapters that are home to many of NGS and Kayenta Mine workers, Window Rock, Fort Defiance, Kykotsmovi, Tuba City and Moenkopi. Job and income losses would occur in the Flagstaff, Gallup, and other off-reservation communities; however, the relative effects of those losses would be less severe.

Local businesses in Page would suffer the loss of revenues tied to the annual overhauls at NGS. Because those overhauls are scheduled to coincide with the off-season for Page tourism, convenience retail, lodging and eating and drinking establishments would be more heavily affected than other sectors of the economy.

Table 3.18-78 Operations and Employment Impacts of the No Action Related to NGS and the Kayenta Mine

Parameter	No Action
Operations	
Annual NGS Power Production	Generation at NGS ceases Electrical generation in the primary segment of the study area decreases by 17.3 TW hours/year
Annual Coal Production	Coal mining likely ceases due to a lack of other customers
Reduction in total production (tons and years at current production rate)	Approximately 203 million tons of additional coal reserves would remain unproduced
Annual groundwater use (acre-feet / year)	Up to 1,200 acre-feet per year less groundwater used
Total groundwater use – 2020 – 2057	Up to 30,000 acre-feet less groundwater used
Water withdrawals from Lake Powell	NGS-related withdrawals would cease
NGS and Kayenta Mine Related Employment	
NGS direct, incl. BM&LP and contractors, annually	-521
PWCC direct, incl. contractors, annually	-519
Overhaul contractors (annual equivalent)	-124
Tribal jobs, annually	-562
Total Indirect/induced jobs, annually	-2,048
Total jobs	-3,212
Job-years lost over 25-year period Current jobs Gains from additional revenues foregone Total losses	 -80,300 - 11,300 -91,600
Labor Income and payments to the tribes and local governments	
Annual labor income	$261 million per year less $6,531 million less over 25 years [1]
Access to fringe benefit programs	Reduced opportunities for current and future workers to realize benefits. Limited alternative employment options with comparable benefits
Long-term pension and retirement income	Substantial reductions in future income for many current and a future generation of workers, extending beyond 2044.

Table 3.18-78 Operations and Employment Impacts of the No Action Related to NGS and the Kayenta Mine

Parameter	No Action
NGS and PWCC lease, royalty, bonus and water payments to the tribes and local governments	$58.5 million/year under current lease and up to $43 million/year in foregone lease and additional payments
Scholarships and community contributions	$700,000 per year less
Reduction in NTUA revenues from electricity sales	Approximately $10 million / year less. Would likely necessitate rate increases for other residential and commercial customers.
Federal Abandoned Mine Lands and Black Lung Funds 2020 to 2044	PWCC payments into these funds would cease -$175 million

[1] Includes $685 million in income foregone that would have accrued under the terms of Lease Amendment No. 1.

Unemployment would rise substantially in the affected areas of the two reservations and in Page; however, the local experience following the closure of the former Black Mesa Mine and Black Mesa pipeline was that many employees with lengthy tenure chose early retirement and did not seek new jobs.

Foregone future sales would cause some businesses to lay off staff, cut back hours for workers, adjust hours of operation, or make other adjustments. Some business closures could occur, particularly in Page and among businesses that may already be weak. Business closures would be apparent by an increase in commercial vacancies. Loss of business from annual overhauls would eliminate the seasonal economic stimulus historically experienced by many local lodging accommodations, fast food, and gas and convenience stores during the off-season for tourism.

Coconino and Navajo counties and the local school districts would see erosion of their tax base and reductions in property tax revenues. Taxing jurisdictions in Coconino County would see the largest reduction, more than $6 million per year. Page would experience erosion of its property tax base and revenues due to declining residential and commercial market values. Future TPT/sales tax receipts due to declining consumer spending and expenditures by NGS participants, PWCC and their vendors would accrue to the Navajo Nation and to local governments in Page, Flagstaff, Gallup, and other off-reservation counties of Coconino, Navajo, and Apache counties.

Sociocultural impacts of the No Action Alternative would be major and long-term. **Tables 3.18-79** and **3.18-80** summarize the primary demographic and sociocultural effects of No Action. The impacts include dislocation and emigration and stresses on families and extended kinship networks as families either move or wage earners relocate in search of employment, leaving their family on the reservation. Because many Navajo and Hopi wage earners support extended, multigenerational families, the closures would likely affect a substantially larger population than a similar off-reservation event in other parts of the nation. Consequently, the closures would result in a decrease in the material standard of living for many Navajo, Hopi, their families, and extended families. The reductions in income would be amplified by the strong cultural and family ties among the Navajo and Hopi, along with a comparative lack of education, training, and work experience, and more limited financial and other resources, that limit their ability and willingness to respond to economic dislocation as is common in many off-reservation situations through emigration. No Action-related population declines would be expected in Page and some Navajo Chapters and Hopi villages. Reductions in NGS and Kayenta Mine related tribal revenues would reduce Navajo Nation governmental services and limit Hopi Tribal services, affecting the quality of life for members of both tribes.

Table 3.18-79 Demographic/Community Impacts of the No Action Related to NGS and the Kayenta Mine

Parameter	Impacts
Labor Market	Local unemployment would increase, potentially dramatically. Effects would be most pronounced in Page and the LeChee, Shonto, Kaibeto, Forest Lake, Kayenta chapters. Some displaced NGS and Kayenta Mine employees with lengthy tenure and vested retirement benefits would choose to retire and maintain their present on or off-reservation residence. Others may relocate for economic reasons, either elsewhere on the reservation or off-reservation, depending on where they find work SRP and PWCC might offer transfers to other facilities to some employees. Additional Navajo and Hopi would become unemployed in response to cutbacks necessitated by reductions in funding. Migration is a common mechanism for labor market adjustment. Some out-migration would be expected to occur, but strong cultural and family ties, and other factors, may temper household migration but encourage long distance commuting for employment (i.e., workers employed out-of-town, sending money back and returning periodically).
Population	Population declines of magnitudes discernible to local residents and community and chapter officials would likely occur in the LeChee, Shonto, Kaibeto, and Forest Lake chapters, and in Page. Secondary population effects would occur over a wider area, including Tuba City, Kayenta, the Flagstaff area and Window Rock, but would be less likely to be discernible. Flagstaff may be a destination for some households who leave Page, the Navajo Nation or Hopi Reservation. A scarcity of available housing and lack of job opportunities on the Navajo Nation contributes to on-reservation relocation challenges. Among those not eligible, or who are financially unable, to retire, many affected families may maintain a local residence, with one or more workers commuting to work on a weekly, or less frequent basis, transferring money back and returning periodically. The costs of commuting and maintaining multiple residences would lower the standard of living for these households.
Effects on local retail and service sector	Businesses in Page, Kayenta, other communities on the Navajo Nation and the Hopi reservation, Page, Flagstaff and elsewhere would see reductions in business revenues due to lower consumer spending and purchases by the proponents, contractors and vendors. Reductions in sales would cause some businesses to lay-off staff or cut back hours for workers (indirect and induced), adjust hours of operation, or make other adjustments. Some business closures could occur, particularly among businesses that may already be weak.
Housing	Greater need for housing assistance would be expected due to loss of income. Housing availability in Page would likely increase as more rentals become available and the number of homes available for sale rises. Home prices and rental rates would soften as supply increases and demand declines.
Community facilities and services	Cutbacks in Navajo and Hopi tribal staffing and services could be expected due to the loss of plant and mine-related revenues. Service cutbacks could affect services across the entire Navajo Nation, but be more strongly felt on the Hopi Reservation. Public facilities and services in Page, Flagstaff and the remainder of Coconino County and Navajo County would see reductions in funding, triggering service level adjustments. Demands for some services would decline due to declining populations. Demands on social services, unemployment, work force training, and other similar services could increase. Reductions in NGS and Kayenta Mine-related revenues could result in budget shortfalls for these services.

Table 3.18-80 Selected Sociocultural Impacts of No Action Related to NGS and the Kayenta Mine

Parameter	Impacts
Economic importance for the Navajo Nation and Hopi Tribe	Most of the workers directly affected by the NGS and Kayenta Mine shutdowns would be Navajo. Loss of NGS and Kayenta Mine-related jobs would lower the material standard of living for those Navajo and Hopi workers unable to find replacement jobs at relatively comparable salaries and benefits, and without major increases in commuting costs. Relocation of wage earners would result in stresses on families. The loss of NGS and Kayenta Mine-related revenues would substantially affect the funding available to the Navajo Nation to deliver services and maintain tribal employment. The loss of Kayenta Mine-related revenues, which comprise over 80 percent of the Hopi Tribe's general fund revenues, would result in severe cutbacks in tribal services and jobs. Loss of services would affect residents throughout the Navajo Nation and Hopi Reservation. Because many Navajo and Hopi wage earners support an extended family, economic effects of closure would be widespread and severe. There is no presently identified or foreseeable commercial or industrial project in the region, including development of renewable energy, with the potential to offset the loss of employment, income and public sector revenues associated with the NGS and Kayenta Mine for northeastern Arizona.
Social and economic importance of NGS for Coconino and Navajo counties and the City of Page	Closure of NGS would adversely affect economic diversity in Page. The loss of the annual NGS overhauls would eliminate a major source of off-season (relative to tourism) commerce for lodging, dining and other retail and service businesses. Closure of NGS also would eliminate NGS corporate and employee support for and participation in civic, service and charitable initiatives.
Transition to renewable energy or natural gas	Because the sources of post-closure replacement power for NGS non-federal partners is not known, transition to renewable energy is not linked to closure.
Air quality, human health and safety, and ecological health concerns	Environmental and health concerns voiced by residents related to NGS and Kayenta Mine would be substantially reduced upon closure and likely cease at the conclusion of reclamation. Concerns about previous health effects could persist. Concerns expressed by residents about potential depletion and degradation of the N-Aquifer would diminish and may cease if long-term effects on the aquifer do not materialize. See Section 3.8 for the assessment of impacts on water resources.
Relocation	Relocations of residents to accommodate mining would cease.
Withdrawal of grazing lands	Withdrawal of grazing lands to accommodate mining would cease.
Homesite leases	The effect of closure on the ability of residents in and near the PWCC lease area to obtain homesite leases is uncertain.
Road safety, maintenance and dust	Road safety and dust issues related to mine operations in and near the PWCC lease would be reduced substantially. Concerns would shift to difficulty in post-closure road maintenance and winter time plowing absent PWCC's efforts and participation.

Table 3.18-80 Selected Sociocultural Impacts of No Action Related to NGS and the Kayenta Mine

Parameter	Impacts
Cultural Resources	Mining-related disturbance of TCPs, places, and landscapes that have cultural and religious significance would cease. Concerns about residual effects on cultural resources and the disposition of previously removed artifacts and burial sites would likely persist.
Cultural Values	Navajo and Hopi who believe that mining is incompatible with traditional culture and beliefs would likely be satisfied with closure of the Kayenta Mine.
Equity	Concern regarding perceived inequities associated with mining and electrical generation to benefit others while those living within and near the lease area experience adverse effects of mining and lack of water service, might decrease, or emerge as concern about residual inequities from past activities and a sense that best opportunities to address those inequities passed with the closure of the mine.
Setting	No additional disturbance of the physical and cultural setting would occur.
	Residents within and near the PWCC lease area who value the traditional setting over employment opportunities and PWCC-supplied coal, water, firewood and services would likely be satisfied upon closure and successful reclamation.

Unless the Navajo Nation negotiated with the NGS Participants to acquire the assets, a decision to implement the No Action Alternative would result in actions to remove and reclaim the BM&LP Railroad ROW. Rails, elements of the catenary system, and rolling stock could be sold as scrap or to another railroad. At-grade crossings, warning signs and other safety devices would be removed. Motorist delays at public at-grade crossings would be eliminated, as would concern for safety at at-grade crossing. ROW fencing would be removed, eliminating the current barrier to herd movements for affected grazing allotments.

3.18.4.7.2 Transmission Systems and Communication Sites

The NGS transmission system is an established part of the western U.S. transmission grid and supports reliability and delivery of power throughout the region, well beyond the power generated by the NGS. Therefore, under the No Action Alternative it is likely that that one, several, or all of the land owners/managers of the transmission line rights-of-way and communication site leases would renew some portion of the facilities to keep the power grid performing as expected.

In the event it is determined that some or all of the transmission systems and communication site ROWs are not renewed, a lengthy study and permitting process would need to occur before any decommissioning is initiated due to the essential and integral nature of these facilities with the western electric grid. As noted in Section 2.3.3, up to 4,826 acres within and alongside the transmission system corridors could be temporarily disturbed if the entirety of the transmission systems and communication sites were decommissioned and removed.

Major new transmission system construction would not be anticipated in conjunction with the No Action. Some upgrades could be required to provide additional transmission capacity in some locations, depending on the source of replacement power in relationship to changes in the future utilization of the WTS and STS in a post-closure environment.

Should capacity upgrades be required, they would likely involve temporary and localized economic and social effects associated with construction of such systems. Such effects can generally be characterized by a relatively small workforce, involving mostly non-local, unaccompanied workers, in a situation where most of the work occurs along a linear corridor located outside of communities. The focus of construction activity shifts location along the corridor over time, reducing or eliminating the effects on some communities, while introducing effects in other locations. The primary socioeconomic effects for affected communities would include temporary lodging demand and revenues and increases in convenience retail and eating and drinking sales and sales taxes. The temporary influx of workers and construction activity can result in increases in traffic and localized congestion, with temporary demands on law enforcement and emergency medical/first responder capabilities. Major adverse social effects on community cohesiveness and lifestyle would be unlikely in conjunction with transmission line upgrades.

In summary, no social and economic effects of consequence would be expected to arise in conjunction with these transmission lines and communication sites.

3.18.4.7.3 Central Arizona Project

A decision to withhold federal approval of those actions necessary to allow operation of NGS and the proposed KMC to continue would necessitate actions on the part of CAWCD to secure an alternative source(s) of 2.7 TW hours of electrical power and energy to operate the CAP system.[34] Replacement energy supply and delivery agreement(s) would need to be in-place and operational not later than December 22, 2019, when NGS is taken off-line. The replacement agreement could involve a short-term purchase agreement to acquire from existing generating sources and a long-term agreement based on power from new source(s), including renewable sources. NREL's analysis indicates projected long-term rates for new construction at approximately $63 per MW hours. Such rates translate to pumping energy costs of $106 per acre-foot. When combined with the long-term uncertainties associated with natural gas rates, and the loss of surplus energy sales that would result, construction of a new facility is seen as economically unsupported.

Based on NREL's analysis, the low-cost short-term option would likely be energy supplied by existing natural gas – combined cycle sources. Depending on market conditions and future prices of natural gas, energy could be available at lower cost than from NGS under the Proposed Action, but it also could be considerably more costly. Based on NREL's analysis, pumping energy costs under No Action could be between 23 percent less costly and 21 percent more costly compared to energy pumping costs under the Proposed Actions. Due to the uncertainty regarding natural gas prices, future energy rates under No Action may be more variable over time than under the Proposed Action. **Table 3.18-81** presents the comparative energy pumping rates and energy costs for the No Action Alternative and the Proposed Action.

Table 3.18-81 Energy Costs Per MW hours – Proposed Action and No Action Alternatives

	2020	2026	2030
Energy Pumping Rates per Acre-Foot			
Proposed Action (3-Unit / 2-Unit)	$80 / $83	$88 / $85	$90 / $95
No Action (new Natural Gas plant)	$106	$106	$106
No Action (power purchase – range)	$61 to $88	$66 to $93	$73 to $106
Annual Pumping Energy Charges for CAP			
Proposed Action	$127,250,000 / $132,640,000	$141,540,000 / $136,150,000	$144,780,000 / $152,320,000
No Action (new Natural Gas plant)	$169,850,000	$169,850,000	$169,850,000

[34] For purposes of this assessment, it is assumed that energy from Hoover Dam would continue to be available to CAWCD at the same cost as it would be assuming the Proposed Action or PFR Alternatives.

Table 3.18-81 Energy Costs Per MW hours – Proposed Action and No Action Alternatives

	2020	2026	2030
No Action (power purchase – range)	$101,640,000 to $139,110,000	$112,690,000 to $156,100,000	$124,290,000 to $175,510,000
Potential for Surplus Energy Sales to support the Development Fund			
Proposed Action	Yes	Yes	Yes
No Action	No	No	No

Surplus energy sales and revenues to support the Development Fund would cease under No Action, regardless of whether pumping energy costs were higher or lower than those under the Proposed Action. Compensating for those reductions venues would require adjustments by CAP to fund debt service. Other resources available for debt service include the capital charges assessed to M&I customers, reserves, ad valorem/property taxes, or adjustments in other budgeted expenditures. CAWCD currently imposes the maximum permissible rate for the latter. The loss of surplus revenue sales could increase pumping energy rates on the order of $10 to $15 per acre-foot. No Action also would result in the loss of contributions to NGS plant reclamation and retirement costs, and retiree health care. Although beyond the scope of this NEPA analysis, the closure of NGS would have other consequences for SRP, Arizona Public Service Company and Tucson Electric Power Company customers who also receive power generated by NGS.

3.18.4.7.4 No Action Impact Summary – All Project Components

Under the No Action Alternative, NGS decommissioning activities would begin in 2018 with effective shutdown of the plant occurring by the end of 2019. The Kayenta Mine would cease operations by the end of 2019 under the No Action Alternative. Mine closure and reclamation procedures would take place pursuant to the existing Kayenta Mine mining permit, and would take approximately 10 to 15 years to complete.

Navajo and Hopi who view mining and burning of coal on tribal lands, and use of tribal water for mining as incompatible with their respective traditional values would likely support the No Action Alternative, in part because mining and coal-fired electric power generation activities would cease and reclamation would occur 25 years sooner than under all action alternatives.

Navajo and Hopi who believe that mining and burning of coal for electric power generation and use of tribal water for mining could be compatible with their respective traditional values would likely oppose this alternative because of the foregone tribal economic, employment and fiscal benefits.

In the absence of the Proposed Action, major socioeconomic effects would occur throughout the study area.

Under the No Action there would be a high likelihood for concurrent effects on Navajo Nation and Hopi Tribe fiscal resources resulting from shutdown activities at NGS and the proposed KMC occurring in the shadow of similar shutdowns of units at FCPP and San Juan Generating Station and reductions in coal production at the respective supply mines. Although separated in distance and timing, the sequential nature of these changes, all precipitated by air quality compliance actions in conjunction with low natural gas prices, would result in negative socioeconomic effects on the Navajo Nation and Coconino and Navajo counties.

Coconino County could experience reductions in TPT revenues due to the residual effects of the shutdown of one unit at the Cholla generating station and effects arising from modification or cancellation of overhauls at NGS in 2017 and 2018. The extent of fiscal effects is uncertain but unlikely to major considering the overall fiscal resources available.

Navajo County could experience adverse fiscal effects due to the residual impacts of the shutdown of one unit at the Cholla generating station and effects arising from the closure of the Kayenta Mine. Apache County could experience fiscal impacts, primarily changes in revenues, arising from the effects on the Navajo Nation fiscal conditions that arise from in conjunction with actions at the NGS, Kayenta Mine, and other generating stations and mines in the region.

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Technical Supplement 3.18-A

Analysis of the Proposed Action and Partial Federal Replacement Alternatives on Water Rates for the Central Arizona Project

Introduction

This technical supplement describes the analysis of the effects on long-term energy costs and water rates for the Central Arizona Water Conservation District's (CAWCD) Central Arizona Project (CAP) that would be associated with the Proposed Action and action alternatives considered in this EIS. CAP's total future annual energy costs would be comprised of three components: cost of NGS energy, energy cost of the alternatives, and energy costs for power obtained from other sources.

The focus of the analysis is on fiscal effects to CAP customers, both those with and without long-term contracts, and those Indian tribes that currently receive deliveries from the CAP. Subsequent effects on end-users of the water and any effects on future economic and community development in the CAP service area due to changes in energy prices are uncertain and beyond the scope of this EIS.

The analysis of future water rates associated with the three partial federal replacement (PFR) alternatives is not indicative of any agreement on the part of CAWCD to accept or participate in the implementation of a PFR should that alternative be approved as part of a Record of Decision for this NEPA action.

The future cost of energy generated by NGS would increase under the Proposed Action, with additional increases projected under all of the action alternatives. Future increases in NGS energy costs would be passed through to Reclamation and the customers of the other NGS participants. In turn, Reclamation's energy costs would pass through to CAWCD. Higher energy costs would translate to increases in water costs for CAWCD's customers, with the relative magnitude of change varying across the different categories of class of customers. For municipal and industrial (M&I) customers on long-term contracts, pumping energy costs represent approximately half of the total rate. For many M&I customers, taking into account the subsequent treatment, distribution, and system operation costs would reduce the relative cost effect on final customers, although the absolute change would be the same. Increases in water cost translate into higher costs of doing business, a reduction in consumer disposable income for other purposes, and higher costs for the public sector (i.e., for irrigation, public recreation and other potable uses).

For Indian tribes and customers in the agricultural settlement pool,[35] energy costs represent their total current rate. Most of the water for these customers is used raw (i.e., untreated) for irrigation. For these users, increases in water rates would translate to higher costs of production and downward pressure on farm income.

CAP water users face a possible further indirect consequence from future increases in energy costs, those associated with the effects on the Lower Colorado River Basin Development Fund. Annual revenues from sale of surplus power, along with property taxes and reserves, are available for application to CAP's debt repayment obligation to the Federal government, up to that year's repayment obligation. Thus, reductions in revenues from surplus energy sales pose a risk for CAP's M&I customers who could face higher capital charges to fund debt service.

[35] The agricultural settlement pool refers to a group of agricultural customers who agreed to relinquish water rights in exchange for water deliveries via the CAP; those deliveries would be billed at the cost to CAWCD of pumping energy only. The pool currently is 400,000 acre-feet per year, decreasing to 300,000 acre-feet per year in 2017, 225,000 acre-feet per year in 2024, and 0 in 2031 (CAP 2015).

The remainder of this technical appendix summarizes the analysis and results of the reasonably foreseeable changes in NGS costs related to the extension of operation through 2044.

Assumptions

- Costs associated with installation and operation of selective catalytic reduction at NGS would be allocated among the participants based on their respective shares of future generating capacity.
- Reclamation's energy costs associated with its participation in NGS would be borne by CAWCD and other purchasers of the power.
- CAP's overall electrical transmission costs would be unaffected by the alternatives.
- The analysis does not include potential costs associated with acquisition of additional transmission capacity in conjunction with the implementation of the Tribal PFR Alternative or the restructuring of existing transmission agreements on the WTS and STS in conjunction with any of the PFR alternatives.
- Reclamation would pay costs through billings to CAP and proceeds of excess power marketed to other customers.
- Monetary values are expressed in 2015 dollars.
- CAWCD would continue to obtain and use 300,000 MW hours per year of energy from Reclamation's Hoover Dam and purchased from other sources. CAWCD's costs of such energy; $14.3 million per year, are assumed to remain constant over time.
- Interim calculations of projected changes in energy costs are rounded to the nearest ten-cent increment, with final results rounded to the nearest whole dollar. This level of precision allows differences between alternatives to be distinguished.
- Reclamation would not build and own a new generation source for replacement power, but rather would work with CAWCD to contract for the purchase of replacement power from other sources.
- Power and energy from a replacement energy source would be dedicated to supplying CAP, with NGS power used to meet the CAP's remaining needs and for sale as surplus.
- The costs of energy from the alternative sources would be borne by the CAWCD.
- The analysis assumes agreement among the NGS participants allowing for the long-term curtailment of a portion of the federal share of NGS output by the quantities associated with the PFR alternatives.
- Potential changes in long-term rates that would be associated with future reductions in deliveries to the Agricultural Settlement Pool are not considered in this analysis.
- The analysis does not specifically account for future cost impacts of residual NGS plant retirement costs. Those costs would accrue under all scenarios, although the timing would differ under the various alternatives.
- Projections of changes in water rates do not include adjustments for the potential effects associated with possible reductions in deliveries associated with shortages on the Colorado River or shifts in deliveries from the agricultural settlement pool to M&I customers.
- Under the No Action Alternative, CAWCD would secure power from a portfolio of sources, using a combination of short and long-term power purchase agreements.

CAP's Future Energy Costs

The projection of future energy costs to CAP begins with a base case of future costs of NGS assuming a continuation of the existing cost structure, allowing for minor increases in operating costs over time. Incremental costs that would occur post-2019, such as the cost of selective catalytic reduction installation, are estimated and summed with the base case costs to derive future costs. For the PFR alternatives, future costs are the weighted average of NGS energy, energy sourced from lower-emitting technology associated with each PFR alternative, and energy obtained from Hoover Dam and purchased from other sources. Costs are established for three time periods (2020 to 2025, 2026 to 2029, and 2030 to 2044), using projected costs for the mid-point of each time period. Those periods generally correspond to the assumed timing of operational changes affecting future NGS production costs:

2020 to 2025: initial period of post-Record of Decision operations during which a) a new photovoltaic solar facility could be built and operated under the Tribal PFR Alternative, b) installation of selective catalytic reduction would occur under the Proposed Action 3-Unit Operation, and c) implementation of the Natural Gas or Renewable PFR Alternative would occur.

2026 to 2029: installation of selective catalytic reduction under the Proposed Action 2-Unit Operation would occur.

2030 to 2044: covers the extended operations through 2044 during which the PFR alternative is assumed to be operational, culminating with the assumed end of the proposed operating period.

Future cost projections for the lower-emitting and renewable technologies are based on NREL's annual baseline series of energy projections, analysis of energy pricing at the Mead hub completed by NREL, and long-term energy pricing projections from the U.S. Energy Information Administration. A range of costs is presented for natural gas generated power; those that represent construction of new generation capacity and a range of costs associated with future power purchases. Costs for the Renewable PFR Alternative assumes power purchased from existing facilities, while those for the Tribal PFR Alternative assume new construction. The base cost assumptions for the NGS and lower-emitting and renewable technologies are shown in **Table 3.18.A-1**.

Table 3.18.A-1 Base Energy Costs per MW hours – NGS and Lower-Emitting Alternative Technologies

	2020 to 2025	2026 to 2029	2030 to 2044
NGS Base [1]			
3-Unit Operation	$44.70	$46.10	$47.50
2-Unit Operation[2]	$46.70	$48.10	$49.50
Partial Replacement Natural Gas/MW hours [3]			
New Natural Gas Plant	$63.00	$63.00	$63.00
Power purchases (range)	$38.60 - $46.80	$41.10 - $50.20	$45.90 - $56.30
Partial Replacement Renewable/MW hours [4]	$61.80	$60.20	$59.80
Partial Replacement Tribal Solar/MW hours	$60.00	$60.00	$60.00

[1] Includes allowances for increases in coal costs based on EIA pricing projections

[2] Base costs for the 2-Unit Operation include an incremental $2/MW hours for fixed costs. Those costs are then allocated across the remaining output associated with 2-Unit Operation PFRs.

[3] Power purchase prices reflect mid-points of projected peak and off-peak price ranges at the Mead hub. Consequently, prices could be above or below the prices shown, and there is no certainty that the average prices for the period would be within the range shown.

[4] Based on 80 percent solar and 20 percent wind energy. For purposes of this analysis, the cost assumptions per MW hours for land-based wind generation during the three time periods are $69, $61 and $59, respectively.

Source: EIA 2015; NREL 2012a.

Factors driving the future costs would include additional lease payments to the Navajo Nation, capital and financing costs associated with installation of selective catalytic reduction, curtailment costs associated with a PFR energy source, and differences in energy prices between NGS and an alternative source. Future changes in operating costs, such as increases in payroll costs, ad valorem and in lieu taxes, and other capital investments, also could contribute to higher energy costs. The following discussions focus on the primary cost variables.

Amendment No.1 to the Indenture of Lease (Lease Amendment No. 1)

Under the terms of Lease Amendment No. 1 (or a leasing agreement with the Navajo Nation having similar terms as Lease Amendment No. 1) the Navajo Nation would receive substantial increases in annual payments from the NGS participants. Those annual payments would include lease payments of $9,000,000 for the 323 ROW grants, increased annual support for scholarships to roughly $250,000, and an additional annual community payment of approximately $180,000. All of these payments would be subject to escalation based on the Consumer Price Index.[36] An additional annual payment of $34,000,000 also would be implemented, based on a 3-Unit Operation and subject to escalation based on the Consumer Price Index. The additional annual payment would be scaled back under a Proposed Action 2-Unit Operation, to $22,666,667 based on a rated capacity of 1,500 MW.

Average annual energy production for the Proposed Action 3-Unit Operation and 2-Unit Operation are 17,400,000 MW hours and 11,658,000 MW hours, respectively. Allocating the incremental lease costs associated with Lease Amendment No. 1 across that production would yield incremental costs per MW hours of $2.50 and $2.70, respectively. Those costs would increase under the PFR alternatives because the annual costs would be allocated across a smaller base of federal energy production (i.e., fewer MW hours of energy). The higher costs would accrue solely to Reclamation's ledger, increasing proportionately to the level of curtailed production for Reclamation. Thus, the largest increase would occur in conjunction with the 250-MW Natural Gas PFR Alternative.[37]

Capital Cost of Selective Catalytic Reduction Installation and Operation

Installation and operation of the selective catalytic reduction pollution control equipment would be the single largest factor driving future increases in cost. There are three variants of selective catalytic reduction that could be installed: conventional selective catalytic reduction, selective catalytic reduction with sorbent injection and a polishing baghouse, and selective catalytic reduction with sorbent injection and a full baghouse. Installation cost estimates vary substantially between variants, generating units, and sources, from $134.4 million to $410.9 million.[38] A decision on which variant would be implemented has not been made. Consequently, an average of the three estimates is used, yielding initial installed cost of $796 million for the 3-Unit Operation and $531 million for the 2-Unit Operation (2015 USD). Installation costs are assumed to be financed using long-term debt, issued at a 5.0 percent interest rate, with a 20-year term for the 3-Unit Operation and 15 years for the 2-Unit Operation.[39] The resulting annual debt service would be $63.4 million (3-Unit Operation) and $50.7 million (2-Unit Operation), equating to average costs of $3.60 per MW hours and $4.40 per MW hours, respectively. Additionally, an allowance of $0.80 per MW hours in operating costs is included (NREL 2012a). The net result would be a projected

[36] For purposes of this analysis, inflationary effects on the lease related payments are assumed to be zero, because they would affect all action alternatives.

[37] The additional annual payments could be reduced by a decision by the NGS participants to pursue a long-term down-rating of the NGS capacity in connection with a Natural Gas PFR Alternative. The analysis does not consider the effects of such a down-rating on annual payments or associated cost implications on the various participants.

[38] See NREL (2012a) "Navajo Generating Station and Air Visibility Regulations: Alternatives and Impacts" for a description of these technologies and a discussion of estimated installation costs.

[39] For this analysis, it is assumed that no U.S. Treasury funds would be used to finance the federal share of the debt. Rather, either CAWCD or participating utility(s) would issue the necessary debt, with increased rates used to provide debt service.

increase of $4.40 per MW hours for the Proposed Action 3-Unit Operation and $5.20 per MW hours for the Proposed Action 2-Unit Operation (**Table 3.18.A-2**).

Table 3.18.A-2 Incremental Costs of NGS Power Associated with Selective Catalytic Reduction Installation

	3-Unit NGS	2-Unit NGS
Installed Selective Catalytic Reduction Capital Cost (millions) [1]		
Selective Catalytic Reduction	$550.9	$367.3
Selective Catalytic Reduction with sorbent injection, polishing baghouse	$603.9	$402.6
Selective Catalytic Reduction with sorbent injection, full baghouse	$1,232.8	$821.9
Installed Capital Cost – Average (millions [rounded])	$796	$531
Term of debt financing	20 years	15 years
Annual debt service payment at 5% interest (millions)	$63.4	$50.7
Incremental Cost / MW hours, incl. $0.80 additional operating	$4.40	$5.20

[1] Capital costs based on NREL 2012a and a cost escalation factor of 1.09.

The incremental costs per MW hours of energy generated by NGS that would be attributable to selective catalytic reduction installation would rise with higher levels of energy sourced from a lower-emitting or renewable technology.

Table 3.18.A-3 presents the energy supply assumptions for this analysis, outlining the total annual power and energy supplied to CAP by NGS and acquired from alternative sources and the federal share of power generated by NGS that would be available for sale as surplus. Not shown, but included in subsequent energy cost estimates, is 300,000 MW hours of energy assumed to be purchased by CAWCD from Reclamation (Hoover Dam) and other sources.

Table 3.18.A-3 Summary Allocation of Federal Power from NGS and Partial Federal Replacement Sources for CAP

Alternative	NGS Supplied to CAP (MW hours)	NGS Available for Surplus (MW hours)	Total NGS Generated (MW hours)	PFR Supplied Power to CAP (MW hours)
Proposed Action 3-Unit Operation	2,696,000	1,472,000	4,168,000	NA
3-Unit/Natural Gas 100 MW	1,819,000	1,472,000	3,290,000	877,000
3-Unit/Renewable 100 MW	2,184,000	1,472,000	3,656,000	511,000
3-Unit/Tribal 100 MW	2,362,000	1,472,000	3,834,000	333,000
3-Unit/Natural Gas 250 MW	505,000	1,472,000	1,975,000	2,192,500
3-Unit/Renewable 250 MW	1,418,000	1,472,000	2,888,000	1,278,000
3-Unit/Tribal 250 MW	1,864,000	1,472,000	3,334,000	831,000
Proposed Action 2-Unit Operation	2,696,000	1,421,000	4,117,000	NA
2-Unit/Natural Gas 100 MW	1,819,000	1,421,000	3,240,000	877,000
2-Unit/Renewable 100 MW	2,184,000	1,421,000	3,605,000	511,000
2-Unit/Tribal 100 MW	2,362,000	1,421,000	3,783,000	333,000

Table 3.18.A-3 Summary Allocation of Federal Power from NGS and Partial Federal Replacement Sources for CAP’

Alternative	NGS Supplied to CAP (MW hours)	NGS Available for Surplus (MW hours)	Total NGS Generated (MW hours)	PFR Supplied Power to CAP (MW hours)
2-Unit/Natural Gas 250 MW	505,000	1,421,000	1,926,000	2,192,500
2-Unit/Renewable 250 MW	1,418,000	1,421,000	2,839,000	1,278,000
2-Unit/Tribal 250 MW	1,862,000	1,421,000	3,283,000	831,000

Note: Annual energy quantities are for a typical year without accounting for the effects of scheduled minor or major maintenance (overhauls) on production.

NA = not applicable.

<u>Charges Associated with Curtailment</u>

The operating agreements for NGS allow a participant to request that power from its share of the plant’s output be curtailed. Curtailment would become a common occurrence of normal plant operations under the PFR alternatives. When curtailment occurs, variable operating costs at NGS are reduced. However, certain fixed costs are still incurred and must be allocated to the remaining production. Unavoidable fixed costs are estimated at approximately $14.00 per MW hours for the Proposed Action 3-Unit Operation and $16.00 per MW hours for the Proposed Action 2-Unit Operation. When those fixed charges are re-distributed based on the level of curtailment associated with each PFR alternative, those charges would add between $4,662,000 and $30,695,000 per year to the costs of the remaining federal share of NGS output. On a “per MW hours generated” basis, the curtailment costs would add between $1.20 and $15.90 annually (**Table 3.18.A-4**).

Table 3.18.A-4 Incremental Costs to Reclamation due to NGS Curtailment Related to Partial Federal Replacement Alternatives

	Annual Charges for Curtailment	Annual Cost per MW hours of Federal Energy from NGS
Proposed Action 3-Unit Operation		
3-Unit/Natural Gas 100 MW	$12,278,000	$3.70
3-Unit/Renewable 100 MW	$7,154,000	$2.00
3-Unit/Tribal 100 MW	$4,662,000	$1.20
3-Unit/Natural Gas 250 MW	$30,695,000	$15.50
3-Unit/Renewable 250 MW	$17,892,000	$6.20
3-Unit/Tribal 250 MW	$11,634,000	$3.50
Proposed Action 2-Unit Operation		
2-Unit/Natural Gas 100 MW	$12,278,000	$3.80
2-Unit/Renewable 100 MW	$7,154,000	$2.00
2-Unit/Tribal 100 MW	$4,662,000	$1.20
2-Unit/Natural Gas 250 MW	$30,695,000	$15.90
2-Unit/Renewable 250 MW	$17,892,000	$6.30
2-Unit/Tribal 250 MW	$11,634,000	$3.50

The direct and proportional relationship between the level of curtailment and the incremental cost for the remaining production of federal power is evident above – as the level of curtailment increases, the cost shift to the remaining production also increases. Thus, the incremental costs due to curtailment that would be associated with 250-MW Natural Gas PFR Alternative would be substantially higher than the 100-MW Tribal PFR Alternative.

Supplemental Costs for Firming/Regulation of Renewable Generation

Solar and wind-powered generation is intermittent, both during the day and on a day-to-day and seasonal basis. To meet the CAP's reliability needs, expected variations on a day-to-day and seasonal basis would be factored into the supply of energy to be obtained from NGS. However, unexpected variations during the day would require firming (i.e., backup generating capacity and power from another source that can be supplied rapidly and on a temporary basis). Provisions for such power are available from other sources that feed into the regional electrical transmission and distribution system. For this assessment, such energy needs are estimated at 6 percent of the annual output provided by renewable sources under the Renewable and Tribal PFR alternatives (NREL 2016). It is assumed that the energy would be supplied by a natural gas facility and at the same $63.00 per MW hours assumed for replacement energy.

Total Future Energy Costs

Reclamation's future energy costs on a MW hours basis derived as the sum of the base cost for NGS with incremental costs associated with changes in the lease costs, curtailment, selective catalytic reduction installation, and firming, rounded to the nearest $0.10, are shown in **Table 3.18.A-5**. As shown, the energy cost associated with the Proposed Action 3-Unit Operation and 2-Unit Operation would be lower than those associated with the Renewable and Tribal PFR alternatives in all instances. In the event of sustained low natural gas prices, projected energy costs under the Natural Gas PFR Alternative could be lower than those for the Proposed Action, but also could be higher if natural gas prices rise. In all cases, the capital costs associated with selective catalytic reduction installation and Lease Amendment No. 1 would add $6.90 or more per MW hours.

Table 3.18.A-5 Estimated Future Energy Charges / MW hours for Federal Power from NGS and Partial Federal Replacement Sources

Alternative	CAP Annual Energy Charges / MW hours [1]		
	2020 to 2025	2026 to 2029	2030 to 2044
Proposed Action 3-Unit Operation	$47.20	$53.00	$54.40
3-Unit/Natural Gas 100 MW			
New Natural Gas Plant	$55.30	$60.00	$61.00
Power purchases (range)	$47.80 - $48.50	$53.20 - $54.70	$55.40 - $57.90
3-Unit/Renewable 100 MW	$52.60	$57.80	$58.60
3-Unit/Tribal 100 MW	$50.50	$55.90	$57.10
3-Unit/Natural Gas 250 MW			
New Natural Gas Plant	$63.50	$65.50	$65.70
Power purchases (range)	$45.10 - $57.60	$49.50 - $62.50	$52.80 - $68.90
3-Unit/Renewable 250 MW	$59.80	$63.80	$63.60
3-Unit/Tribal 250 MW	$55.10	$59.90	$60.90

Table 3.18.A-5 Estimated Future Energy Charges / MW hours for Federal Power from NGS and Partial Federal Replacement Sources

Alternative	CAP Annual Energy Charges / MW hours [1]		
	2020 to 2025	2026 to 2029	2030 to 2044
Proposed Action 2-Unit Operation	\$49.40	\$50.80	\$57.50
2-Unit/Natural Gas 100 MW			
New Natural Gas Plant	\$56.90	\$57.90	\$63.30
Power purchases (range)	\$49.40 - \$54.40	\$51.20 - \$56.40	\$57.70 - \$64.20
2-Unit/Renewable 100 MW	\$54.40	\$55.50	\$61.20
2-Unit/Tribal 100 MW	\$52.50	\$53.70	\$60.00
2-Unit/Natural Gas 250 MW			
New Natural Gas Plant	\$64.00	\$64.30	\$66.60
Power purchases (range)	\$45.00 - \$57.50	\$47.50 - \$60.50	\$52.70 - \$68.70
2-Unit/Renewable 250 MW	\$61.10	\$61.80	\$65.60
2-Unit/Tribal 250 MW	\$56.60	\$57.60	\$63.10

[1] These estimates do not include the costs of power that would be obtained from other sources.

Implementation of any PFR alternative would raise the average and total energy costs to operate the CAP. The lowest cost impact would occur in conjunction with the 100-MW Tribal PFR Alternative, which would involve the least curtailment and sustain high levels of operation at NGS. In the 2020 to 2025 period, rates for the Natural Gas PFR Alternative could be lower if natural gas prices remain low, but also may exceed the cost of NGS if natural gas prices increase.

The largest cost impact would occur in conjunction with the 250-MW Natural Gas Alternative, particularly when assuming a 3-Unit Operation and higher natural gas prices. Under the latter scenario, the share of selective catalytic reduction investment, exclusive of financing costs, that would pass through to Reclamation, and consequently to CAWCD and purchasers of surplus power, would exceed \$190 million. Those costs would then be recovered based on production that would only be approximately 45 percent of that under the Proposed Action. As shown the fully allocated per MW hours cost for the 250-MW Natural Gas PFR Alternative 3-Unit Operation would be as high as \$68.90, which would be as much as 27 percent higher than the Proposed Action. Similar results would occur in conjunction with high levels of replacement from natural gas for the 2-Unit Operation following the installation of Selective Catalytic Reduction.

Implications for CAP's Annual Cost of Pumping Energy

Applying the energy charges presented in **Table 3.18.A-5** to CAP's annual power consumption would yield annual energy costs for energy to be supplied under the Proposed Action or PFR alternatives. The total annual energy costs include a \$14.3 million allowance for the cost of energy obtained from Hoover Dam and energy purchases from the market; that value representing CAWCD's average expenditures for such energy in recent years. Availability and annual outlays for such energy are assumed to be unaffected by the Proposed Action or PFR alternatives.

As noted above, the lowest annual energy costs would be those associated with the Proposed Action. All other alternatives would result in higher costs over the long term. Annual costs for the Proposed Action 2-Unit Operation during the 2026 to 2029 period would be lower than for the Proposed Action 3-Unit Operation due to the selective catalytic reduction debt service associated with the latter. However, costs in the subsequent period would be higher after the selective catalytic reduction debt service begins for the Proposed Action 2-Unit Operation. Ranges of energy charges are shown for the Natural Gas PFR Alternative, including those that would be associated with a new natural gas plant and those associated with purchases from existing sources, the latter being subject to future gas prices. The annual energy charges to CAP for the 2030 to 2044 time period, for all action alternatives, are presented in **Table 3.18.A-6** and shown in **Figure 3.18.A-1**.

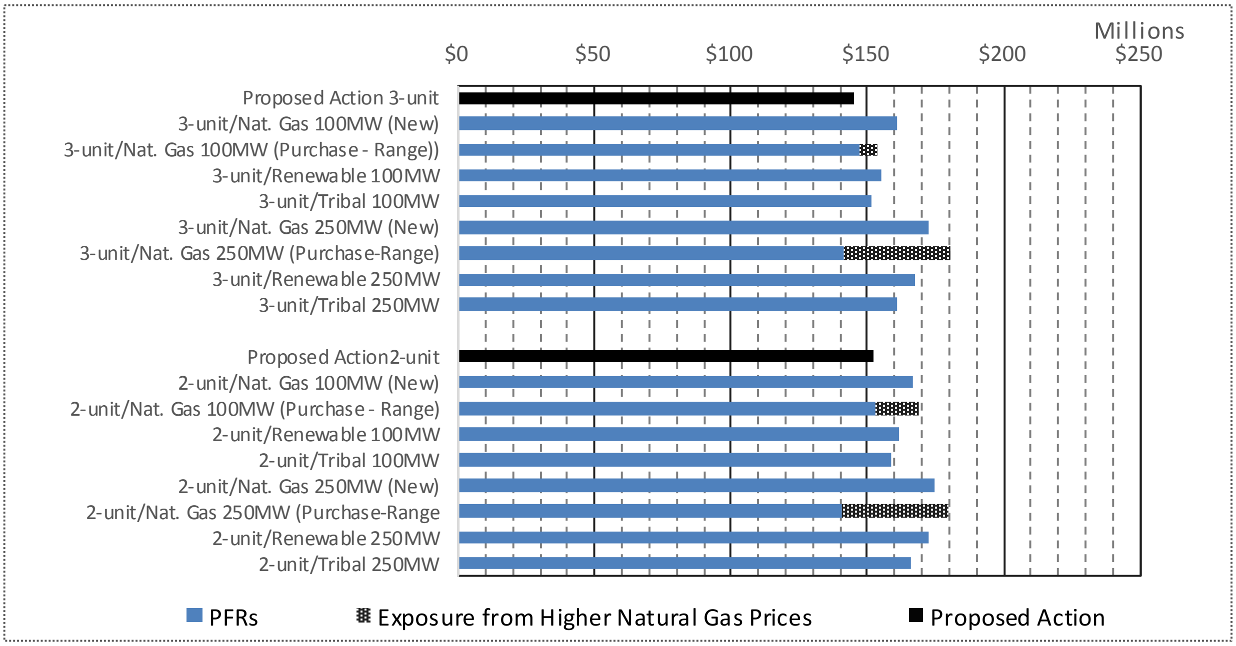

Figure 3.18.A-1 Annual CAP Energy Costs for NGS and Partial Federal Replacement Alternatives, 2030 to 2044

Table 3.18.A-6 Annual Energy Charges to CAP for NGS and Replacement Power

Alternative	Total Annual Energy Charges [1]		
	2020 to 2025	2026 to 2029	2030 to 2044
Proposed Action 3-Unit	$127,250,000	$141,540,000	$144,780,000
3-Unit/Natural Gas 100 MW			
New Natural Gas Plant	$146,930,000	$158,520,000	$160,950,000
Power purchases (range)	$128,870,000 to $130,490,000	$141,810,000 to $145,580,000	$147,200,000 to $153,400,000
3-Unit/Renewable 100 MW	$140,410,000	$153,080,000	$154,960,000
3-Unit/Tribal 100 MW	$135,290,000	$148,490,000	$151,460,000
3-Unit/Natural Gas 250 MW			
New Natural Gas Plant	$166,980,000	$171,830,000	$172,370,000
Power purchases (range)	$122,400,000 to $152,590,000	$132,910,000 to $164,460,000	$141,000,000 to $180,090,000
3-Unit/Renewable 250 MW	$157,990,000	$167,690,000	$167,150,000
3-Unit/Tribal 250 MW	$146,610,000	$158,200,000	$160,620,000
Proposed Action 2-Unit	$132,640,000	$136,150,000	$152,320,000
2-Unit/Natural Gas 100 MW			
New Natural Gas Plant	$150,980,000	$153,400,000	$166,340,000
Power purchases (range)	$132,640,000 to $144,780,000	$126,960,000 to $149,630,000	$152,860,000 to $168,500,000
2-Unit/Renewable 100 MW	$144,720,000	$147,420,000	$161,160,000
2-Unit/Tribal 100 MW	$140,140,000	$143,100,000	$158,470,000
2-Unit/Natural Gas 250 MW			
New Natural Gas Plant	$168,320,000	$168,860,000	$174,530,000
Power purchases (range)	$122,130,000 to $152,320,000	$128,060,000 to $159,600,000	$140,730,000 to $179,550,000
2-Unit/Renewable 250 MW	$161,220,000	$162,840,000	$172,000,000
2-Unit/Tribal 250 MW	$150,000,000	$152,420,000	$165,890,000

[1] Included in the annual energy charges is a $14.3 million annual allowance for the cost of power from Hoover Dam and energy purchases from the market.

Projected annual energy costs on a per acre-foot of water pumped range from $77 to $105 during the 2020 to 2025 period, $83 to $106 during the 2026 to 2029 period, and $88 to $113 during the 2030 to 2044 period (**Table 3.18.A-7**). Costs associated with selective catalytic reduction installation, Lease Amendment No. 1 provisions and underlying increases in basic operating costs would account for approximately $10 of the increase over time for the Proposed Action and PFR alternatives based on a 3-Unit Operation. The corresponding incremental cost for the Proposed Action 2-Unit Operation would be $12. The remaining cost differences between a PFR alternative and the corresponding Proposed Action (**Table 3.18.A-8**), reflect the reallocation of fixed costs, curtailment, firming, and the cost effects of the range of natural gas prices. Future CAP energy costs under the Natural Gas PFR Alternative could be below those of the Proposed Action given sufficiently low natural gas prices.

Table 3.18.A-7 CAP Annual Energy Charges / Acre-Foot

Alternative	Annual Energy Charges / Acre-Foot [1,2] 2020 to 2025	2026 to 2029	2030 to 2044	Net Change 2020 to 2044 (across the row)
Proposed Action 3-Unit	$80	$88	$90	$10
3-Unit/Natural Gas 100 MW				
New Natural Gas Plant	$92	$99	$101	$9
Power purchases (range)	$81 to $82	$89 to $91	$92 to $96	Up to $15
3-Unit/Renewable 100 MW	$88	$96	$97	$9
3-Unit/Tribal 100 MW	$85	$93	$95	$10
3-Unit/Natural Gas 250 MW				
New Natural Gas Plant	$104	$107	$108	$4
Power purchases (range)	$77 to $95	$83 to $103	$88 to $113	Up to $36
3-Unit/Renewable 250 MW	$99	$105	$104	$5
3-Unit/Tribal 250 MW	$92	$99	$100	$8
Proposed Action 2-Unit	$83	$85	$95	$12
2-Unit/Natural Gas 100 MW				
New Natural Gas Plant	$94	$96	$104	$10
Power purchases (range)	$83 to $91	$86 to $94	$96 to $105	Up to $32
2-Unit/Renewable 100 MW	$90	$92	$101	$11
2-Unit/Tribal 100 MW	$88	$89	$99	$11
2-Unit/Natural Gas 250 MW				
New Natural Gas Plant	$105	$106	$109	$4
Power purchases (range)	$76 to $95	$80 to $100	$88 to $112	Up to $36
2-Unit/Renewable 250 MW	$101	$102	$108	$7
2-Unit/Tribal 250 MW	$94	$95	$104	$10

[1] Based on 1,600,000 acre-feet per year.

[2] Equivalent rate for 2016 is $76 / acre-feet (CAWCD 2015b).

Table 3.18.A-8 Difference in CAP Annual Energy Charges / Acre-Foot

Alternative	Difference in Annual Energy Charges / Acre-Foot [1]		
	2020 to 2025	2026 to 2029	2030 to 2044
Proposed Action 3-Unit	na	na	na
3-Unit/Natural Gas 100 MW			
New Natural Gas Plant	$12	$11	$11
Power purchases (range)	$1 to $2	$1 to $3	$2 to $6
3-Unit/Renewable 100 MW	$8	$8	$7
3-Unit/Tribal 100 MW	$5	$5	$5
3-Unit/Natural Gas 250 MW			
New Natural Gas Plant	$24	$19	$25
Power purchases (range)	-$3 to $15	-$5 to $15	-$2 to $23
3-Unit/Renewable 250 MW	$19	$17	$14
3-Unit/Tribal 250 MW	$12	$11	$10
Proposed Action 2-Unit	na	na	na
2-Unit/Natural Gas 100 MW			
New Natural Gas Plant	$11	$11	$9
Power purchases (range)	$0 to -$11	$1 to $11	$1 to $10
2-Unit/Renewable 100 MW	$13	$7	$6
2-Unit/Tribal 100 MW	$5	$4	$4
2-Unit/Natural Gas 250 MW			
New Natural Gas Plant	$12	$21	$14
Power purchases (range)	-$7 to $11	-$5 to $15	-$7 to $17
2-Unit/Renewable 250 MW	$18	$17	$13
2-Unit/Tribal 250 MW	$11	$10	$9

[1] Differences are compared to the appropriate Proposed Action 3-Unit Operation or 2-Unit Operation.

Surplus energy sales of the federal share of NGS power historically have served an important role in CAP financing and in meeting CAWCD's federal debt repayment obligations. Such sales are heavily contingent upon the cost of power from NGS being lower than those from other sources and being available during periods of peak demand. Consequently, rate increases under the PFR alternatives would erode the potential for and realizable revenues from future surplus energy sales. In recent years, gross surplus sales revenue has averaged approximately $42 million annually. Net revenues have been much lower, contributing about one-fourth of CAPs annual repayment obligation.

The per acre-foot energy rate projections shown in **Tables 3-18.A-7** and **Table 3-18.A-8** suggest that the increases in rates stemming from installation of selective catalytic reduction and effects of curtailment on costs associated with the PFR alternatives could pose threats to surplus energy sales, with the incremental costs increasing as a direct function of the levels of replacement energy. For the Natural Gas PFR Alternative, continued low natural gas prices could offer lower rates and result in savings to CAP. On the other hand, rising natural gas prices also would raise rates and undermine surplus energy sales and revenues. As noted above, reductions or the total elimination of such revenues due to the high cost of energy would represent a financial risk to CAP's customers. To compensate for future reductions in surplus revenues would require adjustments by CAP to fund debt service. In addition to surplus, resources available to CAWCD for debt service would include the capital charges assessed to M&I

customers, reserves, and ad valorem/property taxes. CAWCD currently imposes the maximum permissible rate for the latter.

Annual Pumping Energy Costs under No Action

A decision to withhold federal approval of those actions necessary to allow operation of NGS and the proposed KMC to continue would necessitate actions on the part of CAWCD to secure an alternative source(s) of 2.7 TW hours of electrical power and energy to operate the CAP system.[40] Replacement energy supply and delivery agreement(s) would need to be in place and operational not later than December. 22, 2019, when NGS would be taken off line. The replacement agreement could involve a short-term purchase agreement to acquire energy from existing generating sources and a long-term agreement based on power from new source(s), including renewable sources. NREL's analysis indicates projected long-term rates for new construction at approximately $63 per MW hours. Such rates translate to pumping energy costs of $104 per acre-foot. When combined with the long-term uncertainties associated with natural gas rates and the loss of surplus energy sales that would result, construction of a new facility is seen as impractical.

Based on NREL's analysis, the low-cost short-term option likely would be energy supplied by existing natural gas sources. Depending on market conditions, energy could be available at lower cost from existing sources. **Table 3.18 A-9** presents the comparative energy pumping rates and energy costs for the No Action Alternative and the Proposed Action.

Table 3.18.A-9 Energy Costs Per MW hours – Proposed Action and No Action Alternatives

	2020	2026	2030
Energy Pumping Rates per Acre-Foot			
Proposed Action 3-Unit	$80	$88	$90
Proposed Action 2-Unit	$83	$85	$95
No Action (new natural gas plant)	$104	$104	$104
No Action (power purchase – range)	$64 to $87	$70 to $98	$78 to $110
Annual Pumping Energy Charges for CAP			
Proposed Action 3-Unit	$127,250,000	$141,540,000	$144,780,000
Proposed Action 2-Unit	$132,640,000	$136,150,000	$152,320,000
No Action (new natural gas plant)	$165,800,000	$165,800,000	$165,800,000
No Action (power purchase – range)	$101,640,000 to $139,110,000	$112,690,000 to $156,100,000	$124,290,000 to $175,510,000

Compared to the effects under the Proposed Action, the No Action Alternative would result in substantial reductions in regional income and consumer, business, and government expenditures to pay for energy; the loss of surplus revenue sales; and the elimination of continued contributions towards CAP's debt service repayments, plant reclamation and retirement costs, and retiree health care. CAP's energy costs under No Action could be lower or higher than under the Proposed Action depending largely on the future prices of natural gas.

[40] For purposes of this assessment, it is assumed that energy from Hoover Dam and other sources would continue to be available to CAWCD at the same cost and in the same quantities as it would be assuming the Proposed Action or PFR alternatives.

Conclusion

Implementation of either Proposed Action operation would result in higher energy costs to operate the CAP system compared to historical operations (**Table 3.18.A-10**). The higher costs would result from increases in NGS operating costs, increases in lease payments to the Navajo Nation, and environmental compliance costs necessary for operations to continue. The increases in lease payments would be the first substantive increase in such payments since the NGS became operational. The costs increases borne by the CAP, on a per MW hours basis, would be comparable to those borne by all participants in NGS.

Table 3.18.A-10 Annual Energy Charges to CAP for NGS Power – Proposed Action

Alternative	Annual Energy Charges [1] 2020 to 2025	2026 to 2029	2030 to 2044	Net Change 2020 to 2044
Proposed Action 3-Unit Operation				
Annual Energy Charges for NGS-Related Power	$127,250,000	$141,540,000	$144,780,000	$17,530,000
Estimated Energy Rate / acre-foot	$80	$88	$90	$10
Proposed Action2-Unit Operation				
Annual Energy Charges for NGS-Related Power	$132,640,000	$136,150,000	$152,320,000	$19,680,000
Estimated Energy Rate / acre-foot	$83	$85	$95	$10

[1] These costs reflect only the cost of power from NGS, power obtained from Hoover Dam, and purchases from other sources. Costs for transmission and costs associated with load shaping, scheduling or other purposes are not included.

The estimated energy costs in 2020 under the Proposed Action 3-Unit Operation would be $80 per acre-foot, as compared to historical (2016) costs of approximately $76 per acre-foot. Consequently, the estimated future costs in 2020 would represent a 5 percent increase in the energy pumping rate component of CAP's rate, with the $88 costs in 2026 through 2029 representing a 16 percent increase compared to 2016 costs. When considered relative to the total annual costs for the four major categories of customers, the $4 per acre-foot incremental costs between 2020 and 2025 [$80 - $76 = $4] would represent increases of between 2 percent and 5 percent (**Table 3.18.A-11**). The largest relative impact would be for users in the Agricultural Settlement Pool that pay only energy charges. The $14 per acre-foot increment in 2030 to 2044 [$90 - $76] would represent an effective increase of between 8 percent and 18 percent of the current rates. Any future increases in the fixed operations and maintenance of CAPs rates would compound the effects of higher pumping energy costs for M&I customers.

Table 3.18.A-11 Comparative Impact of Energy Charges for CAP Customers

	Total Annual Energy Charges M&I Long-term Subcontract	M&I Non-subcontract and Recharge	Federal	Agricultural Settlement Pool
Firm 2016 Rate per acre-foot	$161	$184	$161	$76
$4 increase as a percent of 2016 firm rate	2%	2%	2%	5%
$14 increase as a percent of 2016 firm rate	9%	8%	9%	18%

In relative terms, the impacts of the higher rates would be more substantive on Indian and non-Indian agricultural interest that use CAP water for irrigation. Because agricultural producers are not able to set the prices for their commodities, increases in production costs typically come from the "bottom line", i.e., lower farm income. Increased production costs and lower income may result in farming operations being scaled back, changes in cropping patterns or the amount of land in production, or in extreme instances, could result in cessation of farming. Agricultural use of water represents approximately 25 to 30 percent of the annual water deliveries by CAP.

For M&I users, the effects of higher energy rates are tempered by the relatively low share that water costs represent to the ultimate cost of potable water to the consumer. Water treatment, storage, distribution and system administration account for the majority of ultimate costs to the consumer. Municipal and industrial water use, including water leased by tribes to other M&I users, represents approximately half of the annual deliveries by CAP. Presumably, those leases provide for energy pumping costs to pass through to the lessee.

The third major customer group is the Central Arizona Groundwater Recharge District and the Arizona Water Banking Authority. The increases in energy costs would result in a direct increase in the water acquisition costs for these two entities. Both entities are funded by a combination of public funds and user and water management fees. Increases in costs may require increases in fees, use of reserves, or other means to address the higher costs.

The increase in energy costs (**Table 3.18.A-12**) would require reductions in consumer, business and government expenditures for other goods and services, some of which would occur within the region, but some of which also would affect non-local expenditures.

Table 3.18.A-12 Difference in CAP Annual Energy Charges / Acre-Foot

Alternative	Difference in Annual Energy Charges / Acre-Foot [1]		
	2020 to 2025	2026 to 2029	2030 to 2044
Proposed Action 3-Unit Operation			
3-Unit/Natural Gas 100 MW			
New Natural Gas Plant	$12	$11	$11
Power purchases (range)	$1 to $2	$1 to $3	$2 to $6
3-Unit/Renewable 100 MW	$8	$8	$7
3-Unit/Tribal 100 MW	$5	$5	$5
3-Unit/Natural Gas 250 MW			
New Natural Gas Plant	$24	$19	$25
Power purchases (range)	-$3 to $15	-$5 to $15	-$2 to $23
3-Unit/Renewable 250 MW	$19	$17	$14
3-Unit/Tribal 250 MW	$12	$11	$10
Proposed Action 2-Unit Operation			
2-Unit/Natural Gas 100 MW			
New Natural Gas Plant	$11	$11	$9
Power purchases (range)	-$11 to $0	$1 to $11	$1 to $10
2-Unit/Renewable 100 MW	$13	$7	$6
2-Unit/Tribal 100 MW	$5	$4	$4

Table 3.18.A-12 Difference in CAP Annual Energy Charges / Acre-Foot

Alternative	Difference in Annual Energy Charges / Acre-Foot [1]		
	2020 to 2025	2026 to 2029	2030 to 2044
2-Unit/Natural Gas 250 MW			
New Natural Gas Plant	$12	$21	$14
Power purchases (range)	-$7 to $11	-$5 to $15	-$7 to $17
2-Unit/Renewable 250 MW	$18	$17	$13
2-Unit/Tribal 250 MW	$11	$10	$9

[1] Differences are as compared to the appropriate Proposed-Action 3-Unit Operation or 2-Unit Operation.

Surplus energy sales of the federal share of NGS power have historically served an important role in CAP financing and in meeting CAWCD's federal debt repayment obligations. Such sales are heavily contingent upon the cost of power from NGS being lower than those from other sources, and being available during periods of peak demand. Consequently, rate increases under the PFR alternatives would erode the potential for revenues from future surplus energy sales. In recent years, gross surplus sales revenue has averaged approximately $42 million annually. Net revenues have been much lower, contributing about one-fourth of CAP's annual repayment obligation.

The per acre-foot energy rate projections shown in **Tables 3-18.A-7** and **Table 3-18.A-8** suggest that the increases in rates stemming from installation of selective catalytic reduction and effects of curtailment on costs associated with the PFR alternatives could pose threats to surplus energy sales, with the incremental costs increasing as a direct function of the levels of replacement energy. For the Natural Gas PFR Alternative, continued low natural gas prices could offer lower rates and result in savings to CAP. Conversely, rising natural gas prices also would raise rates and undermine surplus energy sales and revenues. As noted above, reductions or elimination of such revenues due to the high cost of energy represents a financial risk to CAPs customer's compensation for future reductions in surplus revenues would require adjustments by CAP to fund debt service. Surplus resources available to CAWCD for debt service include the capital charges assessed to M&I customers, reserves, and ad valorem/property taxes. CAWCD currently imposes the maximum permissible rate for the latter.

<u>Annual Pumping Energy Costs under No Action</u>

A decision to withhold federal approval of those actions necessary to allow continued operation of NGS and the proposed KMC would necessitate actions on the part of CAWCD to secure an alternative source(s) of 2.7 TW hours of electrical power and energy annually, to operate the CAP system.[41] Replacement energy supply and delivery agreement(s) would need to be in place and operational not later than December 22, 2019, when NGS is taken off-line. The replacement agreement could involve a short-term power purchase agreement from existing generating sources and subsequent long-term agreements to acquire power from new source(s), including renewable sources. NREL's analysis indicates projected long-term rates for new construction at approximately $63 per MW hour, which translates to pumping energy costs of $104 per acre-foot. When combined with the long-term uncertainties associated with natural gas rates, and the loss of surplus energy sales that would result, construction of a new facility is seen as impractical.

[41] For purposes of this assessment, it is assumed that energy from Hoover Dam and other sources would continue to be available to CAWCD at the same cost and in the same quantities as under the Proposed Action or PFR alternatives.

Based on NREL's analysis, the low-cost short-term option likely would be energy supplied by existing natural gas sources. Depending on market conditions, energy could be available at lower cost from existing sources. **Table 3.18 A-13** presents the comparative energy pumping rates and energy costs for the No Action Alternative and the Proposed Action.

Table 3.18.A-13 Energy Costs Per MW hours – Proposed Action and No Action Alternatives

	2020	2026	2030
Energy Pumping Rates per Acre-Foot			
Proposed Action 3-Unit Operation	$80	$88	$90
Proposed Action 2-Unit Operation	$83	$85	$95
No Action (new natural gas plant)	$104	$104	$104
No Action (power purchase – range)	$64 to $87	$70 to $98	$78 to $110
Annual Pumping Energy Charges for CAP			
Proposed Action 3-Unit Operation	$127,250,000	$141,540,000	$144,780,000
Proposed Action 2-Unit Operation	$132,640,000	$136,150,000	$152,320,000
No Action (new natural gas plant)	$165,800,000	$165,800,000	$165,800,000
No Action (power purchase – range)	$101,640,000 to $139,110,000	$112,690,000 to $156,100,000	$124,290,000 to $175,510,000

As compared to the effects under the Proposed Action, the No Action would result in substantial reductions in regional income and consumer, business, and government expenditures to pay for energy. In addition, the No Action Alternative would result in the loss of surplus revenue sales, and elimination of continued contributions towards CAP's debt service repayments, plant reclamation and retirement costs, and retiree health care. CAP's energy costs under No Action could be lower or higher than under the Proposed Action depending largely on future natural gas prices used to fire combined cycle power plants.

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Section 3.19

Environmental Justice

Acronyms and Abbreviations

1969 Lease	Navajo Project Indenture of Lease
BART	Best Available Retrofit Technology
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BM&LP Railroad	Black Mesa & Lake Powell Railroad
BO	Biological Opinion
CAP	Central Arizona Project
CAWCD	Central Arizona Water Conservation District
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CO_2	carbon dioxide
COPEC	Chemicals of potential ecological concern
Co-tenants	Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
Development Fund	Lower Colorado River Basin Development Fund
EIS	Environmental Impact Statement
ERA	Ecological Risk Assessment
ESA	Endangered Species Act of 1973
HHRA	Human Health Risk Assessment
HQ	Hazard quotient
km	kilometer
KMC	Kayenta Mine Complex
kV	kilovolt
kW	kilowatt
MW	megawatt
N-Aquifer	Navajo Aquifer
NEPA	National Environmental Policy Act of 1969, as amended
NGS	Navajo Generating Station
NGS Participants	U.S. (Reclamation), Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
NHPA	National Historic Preservation Act
NNEPA	Navajo Nation Environmental Protection Agency
NO_2	nitrogen dioxide
NO_X	nitrogen oxide
OSMRE	Office of Surface Mining Reclamation and Enforcement
PA	Programmatic Agreement
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 microns or less
PFR	Partial Federal Replacement

PWCC	Peabody Western Coal Company
Reclamation	U.S. Bureau of Reclamation
ROW	Right-of-way
SO_2	sulfur dioxide
SRP	Salt River Project Agricultural Improvement and Power District
STS	Southern Transmission System
TCP	traditional cultural property
tpy	tons per year
U.S.	United States
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
WTS	Western Transmission System

Contents

3.19 Environmental Justice ... 3.19-1
3.19.1 Regulatory Overview ... 3.19-1
3.19.2 Study Areas ... 3.19-2
3.19.2.1 Proposed Action and Alternatives ... 3.19-2
3.19.2.2 Cumulative ... 3.19-3
3.19.3 Affected Environment ... 3.19-3
3.19.3.1 Navajo Generating Station and Proposed Kayenta Mine Complex ... 3.19-4
3.19.3.2 Central Arizona Project Area of Indirect Socioeconomic Effects ... 3.19-4
3.19.4 Environmental Consequences ... 3.19-5
3.19.4.1 Issues ... 3.19-5
3.19.4.2 Assumptions and Impact Methodology ... 3.19-5
3.19.4.3 Proposed Action ... 3.19-7
3.19.4.4 Natural Gas Partial Federal Replacement Alternative ... 3.19-18
3.19.4.5 Renewable Partial Federal Replacement Alternative ... 3.19-21
3.19.4.6 Tribal Partial Federal Replacement Alternative ... 3.19-25
3.19.4.7 No Action ... 3.19-29
3.19.5 References ... 3.19-32

List of Tables

Table 3.19-1 2010 Minority Populations in the Study Area and Comparative Reference Areas 3.19-3
Table 3.19-2 2010 Low Income Populations in the Study Area and Comparative Reference Areas 3.19-4

3.19 Environmental Justice

Environmental justice is defined by the U.S. Environmental Protection Agency (USEPA) as, "The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people including racial, ethnic, or socioeconomic groups should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal programs and policies" (USEPA 1998).

3.19.1 Regulatory Overview

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, tasks "…each Federal agency [to] make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high adverse human health and environmental effects of its programs, policies, and activities on minority populations and low-income populations." The Executive Order makes clear that its provisions apply fully to programs involving Native Americans (Council on Environmental Quality [CEQ] 1997).

The memorandum accompanying Executive Order 12898 states that each federal agency shall analyze the environmental effects on minority communities and low-income communities, when such analysis is required by the National Environmental Policy Act (NEPA) (USEPA 1994). The accompanying memorandum identifies the following ways to consider environmental justice under NEPA.

1. Each federal agency should analyze the environmental effects, including human health, economic, and social effects, of federal actions, including effects on minority communities and low-income communities when such analysis is required by NEPA.
2. Mitigation measures outlined or analyzed in an Environmental Assessment, Environmental Impact Statement (EIS), or Record of Decision, whenever feasible, should address significant and adverse environmental effects of proposed federal actions on minority communities and low-income communities.
3. Each federal agency shall provide opportunities for community input in the NEPA process, including identifying potential effects and mitigation measures in consultation with affected communities and improving the accessibility of meetings, crucial documents, and notices (Executive Order 12898).

The CEQ environmental justice guidance states that, "Agencies should recognize that the impacts within minority populations, low-income populations, or Indian tribes may be different from impacts on the general population due to a community's distinct cultural practices." One of CEQ's general principles for environmental justice assessment is "Agencies should recognize the interrelated cultural, social, occupational, historical, or economic factors that may amplify the natural and physical environmental effects of the proposed agency action. These factors should include the physical sensitivity of the community or population to particular impacts; the effect of any disruption on the community structure associated with the proposed action; and the nature and degree of impact on the physical and social structure of the community" (CEQ 1997).

The U.S. Department of the Interior NEPA policy states that "To comply with the environmental justice policy established by the Secretary of the Interior, bureaus and offices should identify and evaluate, during the scoping and\or planning processes, any anticipated effects, direct or indirect, from the proposed project, action or decision on minority and low-income populations and communities, including the equity of the distribution of the benefits and risks" (U.S. Department of Interior 1995).

The environmental justice assessment conducted for this EIS includes the following elements:

- Determination of whether the action under consideration would have adverse environmental, human health, economic, social, or cultural effects on any population;
- Description of the environmental justice populations within areas where adverse environmental, human health, economic, social, or cultural effects would occur;
- Determination of whether such environmental, human health, economic, social, or cultural effects would be disproportionately high and adverse on identified environmental justice populations; and
- Description of the opportunities provided for effective participation in the NEPA process.

3.19.2 Study Areas

3.19.2.1 Proposed Action and Alternatives

3.19.2.1.1 Navajo Generating Station and Proposed Kayenta Mine Complex

The Proposed Action and alternatives involve activities on tribal lands within the external boundaries of the Navajo Nation and Hopi Reservation. Although most direct effects of the Proposed Action and alternatives would be concentrated in proximity to the Navajo Generating Station (NGS) and the proposed Kayenta Mine Complex (KMC), secondary effects associated with direct, indirect, and induced economic, employment, and fiscal effects of the Proposed Action and alternatives would accrue throughout the Navajo Nation and Hopi Reservation and in Coconino and Navajo counties in Arizona. The air quality study area includes a 300-kilometer (km) radius from NGS. The public health and human health risk assessment (HHRA) study area includes a 50-km radius from the NGS and proposed KMC emission points. The assessments conducted for air quality and the HHRA did not identify adverse environmental or human health effects on any population within the 300-km or 50-km study areas for those assessments. Consequently, the NGS and proposed KMC environmental justice study area is limited to the Navajo Nation and Hopi Reservation.

3.19.2.1.2 Transmission Systems and Communication Sites

Descriptions of the transmission systems and communication sites are provided in Section 1.7.3 and Section 3.18.3.2. The Western Transmission System (WTS) is approximately 275 miles in length and crosses portions of the Navajo, Kaibab Paiute, and Moapa Paiute reservations, the latter within a Bureau of Land Management reserved right-of-way (ROW) corridor. The Southern Transmission System (STS) is approximately 257 miles in length and crosses portions of the Navajo Nation. There are 19 radio communication sites supporting operations of the plant, railroad, and transmission systems.

3.19.2.1.3 Central Arizona Project Area of Indirect Socioeconomic Effects

The environmental justice assessment for the Central Arizona Project (CAP) area of indirect socioeconomic effects is focused on the counties and reservations where the CAP water deliveries are made to CAP customers and where the associated indirect socioeconomic effects likely could occur, rather than on the areas surrounding the entire physical CAP system. The study area for potential indirect environmental justice effects on CAP customers includes those parts of Maricopa, Pinal, and Pima counties in central and southern Arizona (**Table 3.18-1**) where CAP water deliveries are made.

Section 1.3 and Section 3.18.3.3 describe the CAP and its relationship to the NGS. The 336-mile-long CAP system traverses much of southwestern Arizona, from Lake Havasu in La Paz County to the southern boundary of the San Xavier Indian Reservation southwest of Tucson in Pima County. CAP water deliveries are made to municipal and industrial water users, agricultural users, and CAP tribes in Maricopa, Pinal, and Pima counties, Arizona. Portions of the San Carlos Apache tribal land are located in Gila and Graham counties, Tonto Apache tribal land is located in Yavapai County, and White Mountain Apache tribal land is located in Navajo and Apache counties; however, none of the CAP system is located in those counties. Fort McDowell,Yavapai Apache, and the Salt River Pima-Maricopa Indian Community do not currently utilize CAP water on their reservations, allowing them to direct their CAP allocations for other purposes.

3.19.2.2 Cumulative

The cumulative study areas for environmental justice are the same as those described for the Proposed Action and alternatives.

3.19.3 Affected Environment

The resident population of the Navajo Nation and Hopi Tribe includes sufficient numbers of minority and low-income residents to warrant consideration under the environmental justice guidelines of Executive Order 12898. **Table 3.19-1** summarizes minority population characteristics for the Navajo and Hopi tribes, as well as Navajo and Coconino counties, the latter of which contain portions of the Navajo Nation and the entire Hopi Reservation. CEQ guidelines specify that, "Minority populations should be identified where either: (a) the minority population of the affected area exceeds 50 percent or (b) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis" (CEQ 1997). In 2010, Native Americans and other racial and ethnic minorities comprised 97.9 percent of all residents on the Navajo Nation and 97.5 percent of all residents on the Hopi Reservation. As might be expected, the vast majority of these minority populations were Native Americans. Consequently on the basis of race alone, the Navajo Nation and Hopi Reservation qualify as environmental justice populations.

The population of Navajo County was comprised of 56.1 percent Native Americans and other racial and ethnic minorities, and Coconino County was comprised of 44.8 percent. The Coconino and Navajo County racial and ethnic minority populations include the Navajo and Hopi within the respective counties. In comparison, the State of Arizona as a whole was comprised of 42.2 percent minorities, and the population of the U.S. at the time of the 2010 census was 36.3 percent minority (U.S. Census Bureau 2010).

Table 3.19-1 2010 Minority Populations in the Study Area and Comparative Reference Areas

Geographic Area	Total Population	Percent White and Not Hispanic or Latino	Percent Minority	Percent Native American
Navajo Nation (Arizona portion)	101,835	2.1	97.9	97.1
Hopi Reservation	7,185	2.5	97.5	96.2
Apache County	71,518	20.4	79.6	74.5
Coconino County	134,421	55.2	44.8	28.9
Navajo County	107,449	43.9	56.1	44.9
State of Arizona	6,392,017	57.8	42.2	5.5
United States	308,745,538	63.7	36.3	1.7

Source: U.S. Census Bureau 2010.

The two reservations qualify as low-income-related environmental justice populations. The incidence of poverty on the Navajo Nation and Hopi Reservation is much higher than the State of Arizona as a whole (**Table 3.19-2** and Section 3.18.3.1 discussion of Personal Income). The U.S. Census Bureau's 2009 to 2013 American Community Survey estimated that 41.2 percent of the residents on the Arizona portion of the Navajo Nation and 31.8 percent of the population on the Hopi Reservation had incomes below the poverty threshold. The comparable estimates were 30.3 percent for Navajo County and 23 percent for

Coconino County. In comparison, 17.9 percent of the population in the State of Arizona and 15.4 percent of the population in the U.S. were estimated to be below the poverty level.

Table 3.19-2 2010 Low Income Populations in the Study Area and Comparative Reference Areas

Geographic Area	Per Capita Income (2013 dollars)	Income Below Poverty[1] (percent)
Navajo Nation (Arizona portion)	$10,840	41.2
Hopi Reservation	$12,989	31.8
Apache County	$12,709	36.2
Coconino County	$23,382	23.0
Navajo County	$16,626	30.3
State of Arizona	$25,358	17.9
United States	$28,155	15.4

[1] Based on 2009-2013 American Community Survey.

Source: U.S. Census Bureau 2014a,b.

3.19.3.1 Navajo Generating Station and Proposed Kayenta Mine Complex

In addition to the CEQ (1997) environmental justice guidance noted above, CEQ environmental justice guidance under NEPA further specifies that, "In identifying minority communities, agencies may consider as a community either a group of individuals living in geographic proximity to one another, or a geographically dispersed/transient set of individuals (such as migrant workers or Native Americans), where either type of group experiences common conditions of environmental exposure or effect. The selection of the appropriate unit of geographic analysis may be the jurisdiction of a governing body, a neighborhood, census tract, or other similar unit that is to be chosen so as to not artificially dilute or inflate the affected minority population (CEQ 1997).

Within the larger environmental justice populations on the Navajo Nation, persons living near NGS and associated facilities primarily have voiced concerns about the effects of emissions from NGS. Persons residing within the vicinity of the proposed KMC have been and continue to be affected by mining activities, relocation, withdrawal of grazing lands, alteration and removal of traditional cultural properties (TCPs), sacred sites, and burials, and change in the cultural landscape and setting (Section 3.18.3.1). In defining the purpose and authority of the Black Mesa Review Board (described in the Kayenta/Black Mesa Lease Area Oversight and Planning subsection in Section 3.18.3.1), the Navajo Nation Code acknowledges the potential for adverse effects and impacts of coal mining and related operations on the socioeconomic and environmental interests of Navajo families living within the five chapters (Black Mesa, Chilchinbeto, Forest Lake, Kayenta, and Shonto) that contain or are adjacent to the proposed KMC (Title 2 Navajo Nation Code, Chapter 3, Subchapter 11, Article 5, Section 902). Therefore, persons living within and adjacent to the proposed KMC merit specific consideration under environmental justice guidelines.

3.19.3.2 Central Arizona Project Area of Indirect Socioeconomic Effects

As described in Section 3.18.3.3, the CAP delivers water to municipal and industrial water users, agricultural users, and CAP tribes in Maricopa, Pinal, and Pima counties, Arizona, which had a combined 2010 population of 5,173,150 (**Table 3.18-24**). At the time of the 2010 Census, 58.7 percent of the Maricopa and Pinal County population and 55.3 percent of the Pima County population was white alone, not Hispanic or Latino. Maricopa and Pinal counties were 42.2 percent all other races, and Pima County was 44.7 percent all other races. The comparable percentages for the U.S. were 63.7 percent white alone, Hispancic, or Latino and 36.3 percent minority (U.S. Census Bureau 2016). Consequently, considered in their entirety, the residents of the three counties as a whole do not comprise an environmental justice population on the basis of race.

Within the three counties, the percentage of persons living below the poverty level at the time of the 2010 Census was 13.9 percent for Maricopa County, 13.5 percent for Pinal County, and 16.4 percent for Pima County. The comparable statistic for the U.S. was 13.8 (**Table 3.18-26**). Consequently, the residents of the three counties considered in their entirety do not comprise an environmental justice populations on the basis of income.

The reservations of the 10 tribes with Colorado River allocations (**Table 3.18-24**) are environmental justice populations based on racial considerations. Eight of the 10 tribes, excluding the Fort McDowell Yavapai and the Pascua Yaqui, also are considered environmental justice populations based on the meaningfully greater percentage of reservation residents below the poverty level as compared to those in surrounding counties, the State of Arizona, and the nation as a whole (**Table 3.18-26**).

3.19.4 Environmental Consequences

3.19.4.1 Issues

Impacts to environmental justice populations in the areas surrounding the NGS and within and adjacent to the proposed KMC are discussed relative to each of the following resources.

- Air Quality
- Water Resources
- Hazardous Materials
- Public Health and Human Health
- Cultural Resources
- Socioeconomic Conditions

Impacts to environmental justice populations in the CAP area of indirect socioeconomic effects pertain primarily to changes in:

- Electrical power and pumping costs for CAP and its users; and
- Contributions to the development fund.

3.19.4.2 Assumptions and Impact Methodology

Section 3.19.2.1 describes the study area for the environmental justice assessment for NGS and the proposed KMC. In Section 3.19.3, residents of the Navajo Nation and Hopi Reservation were identified as environmental justice populations based on the concentration of minority and low-income populations on both reservations.

The assessment for environmental justice draws on the findings of the air quality, water, geology, minerals, soils, and biological resources; land use; public health and human health; hazardous materials; cultural and paleontological resources; and socioeconomic assessments conducted for this EIS to identify:

- Whether the Proposed Action or alternatives would have adverse environmental, human health, economic, social, or cultural effects on any population; and
- Whether such environmental, human health, economic, or social effects would be disproportionately high and adverse on identified environmental justice populations.

For determination of disproportionately high and adverse human health effects, CEQ (1997) guidance requires consideration of the following:

(a) Whether the health effects would be significant (as employed by NEPA) or above generally accepted norms;

(b) Whether the risk or rate of hazard exposure by a minority population, low-income population, or Tribe to an environmental hazard would be significant (as employed by NEPA) and would appreciably exceed the risk or rate to the general population or other appropriate comparison group; and

(c) Whether health effects would occur in a minority population, low-income population, or Tribe affected by cumulative or multiple adverse exposures from environmental hazards.

For determination of disproportionately high and adverse environmental effects, CEQ (1997) guidance requires consideration of the following three factors:

(a) Whether there is or would be an impact on the natural or physical environment that would significantly (as employed by NEPA) and adversely affects a minority population, low-income population, or Tribe. Such effects may include ecological, cultural, human health, economic, or social impacts on minority communities, low-income communities, or Tribes when those impacts are interrelated to impacts on the natural or physical environment;

(b) Whether environmental effects would be significant (as employed by NEPA) and have an adverse impact on minority populations, low income populations, or Tribes that would appreciably exceed those on the general population or other appropriate comparison group; and

(c) Whether the environmental effects would occur in a minority population, low-income population, or Tribe affected by cumulative or multiple adverse exposures from environmental hazards.

CEQ environmental justice guidance states…"Under NEPA, the identification of a disproportionately high and adverse human health or environmental effect on a low-income population, minority population, or Indian tribe does not preclude a proposed agency action from going forward, nor does it necessarily compel a conclusion that a proposed action is environmentally unsatisfactory. Rather, the identification of such an effect should heighten agency attention to alternatives (including alternative sites), mitigation strategies, monitoring needs, and preferences expressed by the affected community or population" (CEQ 1997).

3.19.4.2.1 Public Participation of Minority and Low-Income Populations

As noted in Section 3.19.1, providing opportunity for community input is a requirement for the process to address potential environmental justice concerns. The U.S. Bureau of Reclamation (Reclamation) initially held 10 public scoping meetings in 2014. Meeting sites were located to encourage participation from Tribal governments, residents of communities near the NGS and the Kayenta Mine, and water users in the CAP service area. The meetings were conducted in an informal open house format. Court reporters were available at each meeting to record oral comments. At scoping meetings held on the Navajo and Hopi reservations, Navajo and Hopi interpreters were available to assist attendees in conversing with project team members in attendance, interpret information presented on a series of posters, and assist with the interpretation of oral comments made to the court reporters. English, Navajo, and Hopi language versions of a project video were available for viewing at each meeting, providing an overview of the NEPA process, the Proposed Action, environmental assessment topics, public involvement opportunities, and guidelines for providing substantive comments.

The Office of Surface Mining Reclamation and Enforcement conducted informal conferences concurrently with the open house scoping meetings at Forest Lake Chapter and Kayenta on the Navajo Nation, and at Kykotsmovi on the Hopi Reservation. A handout with summaries of the poster, a comment form, and a fact sheet were supplied for the informal conferences, as required by Surface Mining Control and Reclamation Act regulations for the Kayenta Mine permit revision application.

At the request of the Hopi Tribe, Reclamation reinitiated and extended the public scoping comment period, publishing a notice in the July 25, 2014 *Federal Register* announcing extension of the public scoping comment period through August 31, 2014. The extension provided an opportunity for expanded public involvement activities including community outreach and an additional public scoping meeting on the Hopi Reservation.

Reclamation and Office of Surface Mining Reclamation and Enforcement held meetings with residents living in the vicinity of the proposed KMC on July 26, 2015, and August 28, 2015. These meeting were to allow residents to voice issues and concerns regarding the mine and mining activities. Both meetings were held at the Peabody Western Coal Company (PWCC) Human Resources Center. More than 65 residents attended the two meetings, 29 of whom offered comments. A Navajo translator was provided for those who preferred to offer comments in the Navajo language (note that no Hopi live within the proposed KMC area). The meetings were followed by a series of resident interviews to further explore these issues, again with the assistance of a Navajo language interpreter.

The Navajo Nation is a Cooperating Agency for the EIS and Cooperating Agency status has been offered to the Hopi Tribe. Section 1.10 provides more detail regarding the scoping process conducted for this EIS and the specific opportunities provided for low income and minority participation in the scoping process. This section also provides a description of the Government-to-Government consultations between Reclamation and the affected tribes during the EIS process.

3.19.4.3 Proposed Action

3.19.4.3.1 Navajo Generating Station

3.19.4.3.1.1 Air Quality

According to Section 3.1.4.3, air quality impacts from NGS operations would be moderate under the Proposed Action. All criteria pollutant emissions would be in compliance with the national ambient air quality standards, and not expected to cause deleterious impacts to human health or the environment. Negligible direct and indirect impacts to ozone, regional haze, and acid deposition would be anticipated. Although increases in fugitive dust and equipment emissions would occur during decommissioning over a 5 to 10 year period starting in 2044, increases would be short-term and minor. Based on these findings, no disproportionately high and adverse air quality effects on environmental justice populations are anticipated under the Proposed Action.

3.19.4.3.1.2 Water Resources

NGS obtains water from Lake Powell from Arizona's share of the Upper Colorado River Basin. The use of Colorado River water by NGS is supported by Navajo tribal resolution.

As described in Section 1.7.1.4 and Section 3.7.4.2, NGS withdrawals from Lake Powell would create negligible impacts on reservoir water levels and the extent of the lake water surface. Negligible amounts of arsenic, mercury, or selenium would be deposited on Lake Powell or the nearby Colorado River from plant emissions. NGS is designed to be a zero discharge facility and has implemented a Groundwater Protection Plan, a Perched Water Dewatering Plan, and compliance measures for USEPA's Coal Combustion Residual Rule. These plans and measures include groundwater monitoring, formalized inspections and testing, engineering controls to avoid and minimize loss and transmission of NGS plant waters into the ground, measures to capture and reclaim water that has saturated soils, and implementation of additional Best Management Practices for protecting groundwater. These plans and measures were designed to ensure that water quality in the regional Navajo Aquifer (N-Aquifer), approximately 900 feet below the surface level, would not be impacted by operations and decommissioning. See Section 3.7.4.2 and **Appendix 1B** for a full description of these plans and requirements.

Under the Proposed Action, the operating and support facilities at the plant site would be dismantled and demolished to ground level by the end of 2045, unless the Navajo Nation continues NGS operations beyond 2044. The overall decommissioning process is described in **Appendix 1B**. A comprehensive environmental site assessment would be conducted to determine if there would be any sources or paths of contamination and to identify environmental receptors and develop remedial alternatives, if applicable. Phase I of the site assessment would include a records review, site visit, regulatory review, and hydrogeologic review to determine if environmental contamination, which may result in future environmental liability likely would be present at the property. Phase II of the site assessment would consist of on-site sampling to determine if environmental issues exist. A sampling and analysis plan would be developed to identify sample locations, sampling methodologies, analytical parameters, and a quality assurance plan. As required in the 1969 Lease, the land would be restored as closely as possible to original condition.

Based on the findings of the water assessment conducted for the EIS (Section 3.7.4) and the above-described decommissioning requirements, no disproportionately high and adverse effects on environmental justice populations from NGS-related changes in water resources would be anticipated in association with the Proposed Action.

3.19.4.3.1.3 Hazardous Materials

<u>Coal Combustion Residuals</u>

As noted in Section 3.15 and **Appendix 1B**, the disposal of NGS coal combustion residuals in compliance with USEPA's Coal Combustion Residual Rule, which includes groundwater and air quality protection measures, would result in minor impacts to the environment. As described under water resources above, performance of the Phases I and II Comprehensive Environmental Site Assessment and compliance with the provisions of the1969 Lease would mitigate the risk of long-term storage of coal combustion residuals on the NGS site. Consequently, no disproportionately high and adverse effects on environmental justice populations would be anticipated in association with disposal of coal combustion residuals under the Proposed Action.

<u>Products and Chemical Transportation</u>

As described in Section 3.15, large quantities of both anhydrous ammonia and diesel fuel would be transported to NGS under the Proposed Action. Based on the analysis conducted for this EIS, the immediate effects of a transportation incident or accident could be severe for either substance, especially if cargo or fuel tanks were to rupture and major spill occurred. However, the probability of an accident or in-transit release would be low, and the potential adverse effects would be short-term and localized. Moreover, the risk of transportation accidents would occur along all major transportation routes from product origins to NGS and would be similar to the risks associated with other fuel and chemical transportation risks on those routes with negligible impacts. NGS maintains a hazardous response team that would be available for spills in the area. Consequently, no adverse health or safety effects or disproportionately high and adverse effects on environmental justice populations associated with products and chemical transportation would be anticipated under the Proposed Action.

3.19.4.3.1.4 Public Health and Human Health

Two HHRAs were conducted for this EIS. These HHRAs concluded that emissions from NGS as well as the combined emissions from NGS and the proposed KMC would result in negligible impacts on human health in the vicinity of NGS. The HHRA was designed to ensure that a high degree of conservatism was built into the risk assessment methods and thresholds, resulting in an assessment that was highly protective of public health (Section 3.16). The HHRAs concluded that no adverse health effects or disproportionately high and adverse effects on environmental justice populations would result under the Proposed Action.

3.19.4.3.1.5 Cultural Resources

As noted in Section 1.7.1, it is possible that the NGS coal combustion residual landfill would be expanded under the Proposed Action 3-Unit Operation to accommodate the disposal of nearly 23 million cubic yards of coal combustion residuals. The actual quantity that would be placed in the landfill would depend on the amount of fly ash marketed during the 2019 to 2044 time period. Continued operation could require up to an additional 80 acres within the current area leased for the landfill.

Additional wastewater evaporation pond capacity may be required under the Proposed Action 3-Unit Operation to facilitate the efficient operation of the zero discharge facility (Section 1.7.1). Any future pond construction would occur within the existing plant site, following the guidelines described in **Appendix 1B**.

According to Section 3.17, the foreseeable maximum footprint of the coal combustion residual landfill was previously investigated for cultural resources and no National Register of Historic Places-eligible or listed historic properties identified were within this area. Section 3.17 also describes the NGS Programmatic Agreement identifying the steps that Reclamation and the consulting parties agree to follow in resolving any adverse effects that the project might have on historic properties. The NGS Programmatic Agreement has been developed in consultation with the agencies, Tribes, and organizations listed on **Table 3.17-3**. This programmatic agreement outlines general and specific measures that Reclamation would take to fulfill its responsibilities to protect historic properties under the National Historic Preservation Act as well as Tribal and state laws. Any adverse effects on historic properties that may result from the project alternatives would be resolved through implementation of the stipulations in the NGS Programmatic Agreement.

Under the Proposed Action 2-Unit Operation, no additional landfill capacity or new evaporation ponds would be required, thereby avoiding concerns of future effects on cultural resources. No new disturbance in association with operations and maintenance of the Black Mesa & Lake Powell Railroad would be anticipated under the Proposed Action.

Based on the requirements of the NGS Programmatic Agreement and the participation of the affected tribes in developing and implementing the Proposed Actions, impacts to cultural resources would be negligible. No adverse impacts to cultural resources or disproportionately high and adverse cultural resource-related effects on environmental justice populations would be anticipated for NGS under either the Proposed Action 3-Unit Operation or 2-Unit Operation.

3.19.4.3.1.6 Socioeconomic Conditions

Under the Proposed Action, NGS would generate substantial economic, employment and fiscal benefits for the Navajo Nation and Coconino County from 2020 to 2044. The current economic, fiscal and social benefits associated with NGS would increase compared to levels associated with existing operations, based on higher NGS payments to the Navajo Nation (Section 3.18.4.3). Under the Proposed Action 3-Unit Operation, NGS would support an estimated total of 2,164 direct, indirect and induced jobs (**Table 3.18-33**). Most of the direct, onsite contractor, annual overhaul, and related tribal jobs at NGS would be held by Native American (primarily Navajo) workers. Additionally, many of the more than 1,100 estimated indirect and induced jobs also would be held by Navajo workers. Estimated NGS payments to the Navajo Nation would total $43 million per year and over $1.07 billion over the period from 2020 to 2044 (**Table 3.18-35**). This would represent a 1,400 percent increase in payments compared to current lease payments. These fiscal benefits would fund tribal services throughout the Navajo Nation.

Under the Proposed Action 2-Unit Operation, total NGS-related employment (direct, indirect, and induced) would total 1,616 jobs, which would be 25 percent lower than under the 3-Unit Operation (**Table 3.18-33**). Estimated NGS payments to the Navajo Nation would total nearly $32 million per year and $793 million over the period from 2020 to 2044, which would be 26 percent less than the 3-Unit Operation (**Table 3.18-35**). This would represent a 1,000 percent increase in payments compared to current lease payments.

Both the Proposed Action 3-Unit Operation and 2-Unit Operation would provide income to the Navajo Nation, which in turn could support tribal employment. Implementation of the 2-Unit Operation would result in lower direct employment at NGS than either the 3-Unit Operation or existing operations. The reductions in NGS direct jobs and much of the reductions in indirect and induced jobs likely would involve Navajo workers residing in Page, LeChee, Kaibiito, and Kayenta. Jobs added in response to higher NGS payments more likely would be located in Window Rock and elsewhere throughout the Navajo Nation, which could result in higher unemployment in Page and the chapters surrounding NGS than that described in Section 3.18.3.1.

Given that both the 3-Unit Operation and 2-Unit Operation would support substantial economic, employment and fiscal benefits for Navajo workers and the Navajo Nation as a whole, no disproportionately high and adverse socioeconomic effects on environmental justice populations would be anticipated in association with the Proposed Action.

3.19.4.3.2 Proposed Kayenta Mine Complex

3.19.4.3.2.1 Air Quality

The conclusions of Section 3.1.4.3 indicate that air quality impacts from the Proposed Action would be below the ambient air quality standards for all criteria air pollutants. Short-term minor increases in fugitive dust and equipment emissions would occur during decommissioning over a 2- to 3-year period starting in 2044. Consequently, no disproportionately high and adverse effects on environmental justice populations from proposed KMC emissions would be anticipated in association with the Proposed Action.

3.19.4.3.2.2 Water Resources

Under the Proposed Action, water withdrawals from the N-Aquifer would continue, and the Navajo Nation and Hopi Tribe would receive future water fees, averaging more than $1.3 million annually and $33 million over the period from 2020 to 2044. Water fees in the future are expected to be higher under the Proposed Action. An increase in water rates, retroactive to 2015, is pending approval by the Hopi Tribal Council and the Secretary of the Interior. To date, details of the new rate have not been released.

There would be no changes to N-Aquifer water quality. Effects on stream baseflows would be none to negligible, depending on the stream. Similarly, the potential impacts to discharges at N-Aquifer springs from either Proposed Action operation would be none to negligible.

Project impacts on groundwater levels in the Wepo Formation and alluvial aquifers within and adjacent to the leasehold would be negligible. Water quality effects in the Wepo Formation, alluvial aquifers, and associated springs and seeps would range from none to minor, and would be localized to a few isolated locations within the leasehold. Any impacts to existing water uses would be mitigated by the mine through ponds and impoundments and ongoing seep mitigation. Impacts on water quantity and quality in the Wepo Aquifer also would be negligible.

Based on the findings in Section 3.7.4.2, impacts to water resources associated with Proposed Action mining activities would be negligible to minor; therefore, no disproportionately high and adverse effects on environmental justice populations would be anticipated under the Proposed Action.

3.19.4.3.2.3 Hazardous Materials

As discussed in Section 3.15, the most commonly used products and chemicals at the Kayenta Mine are diesel fuel and blasting explosives. Based on the analysis conducted for this EIS, the risk of a diesel fuel-related transportation incident would be low at the volumes estimated for the Proposed Action and fuel deliveries would be substantially reduced under the Proposed Action 5.5 million tons per year (tpy) Operation. Consequently, no disproportionately high and adverse effects on environmental justice populations would be anticipated from transportation of diesel fuel under the Proposed Action.

Storage and use of blasting explosives occurs at the mine in conformance with federal regulations (30 Code of Federal Regulations Parts 56, 57, and 816.61 – 68, Safety Standards for Explosives at Metal and Nonmetal Mines; Use of Explosives) and numerous federal mine safety policies and procedures, including local notification procedures. PWCC has established procedures to monitor possible structural damage due to blasting as described in Section 3.18.3.1. Consequently, no disproportionately high and adverse human and environmental effects from storage and use of explosives would be anticipated under the Proposed Action.

3.19.4.3.2.4 Public Health and Human Health

Cancer and non-cancer risk estimates for the general population associated with proposed KMC emissions and fugitive dust would be within USEPA acceptable risk ranges for the Proposed Action (Section 3.16.4). Particulate matter with an aerodynamic diameter of 2.5 microns or less ($PM_{2.5}$) concentrations associated with proposed KMC operations would meet national ambient air quality standards criteria and would have little to no effects on the health of the general population.

The public health assessment concluded that the sustained employment associated with continued operations of the NGS and proposed KMC under the Proposed Action, the associated increase in revenues to the Navajo Nation and Hopi Tribe through extension of lease and coal royalties, and the income associated with sustained long-term employment, and potentially increased employment opportunities, could lead to major positive health impacts, continued or improved access to health services, better nutrition, and better overall well-being. These positive effects would accrue to direct, indirect, and induced workers and their families associated with NGS and the proposed KMC, a large percentage of which would be Navajo and Hopi workers. Furthermore, extending the operating life of NGS and proposed KMC to 2044 would support ongoing employment income and future retirement income for many households beyond the operating life of the plant (Section 3.18). Those benefits take on added importance given the persistent high unemployment and poverty among the Navajo.

For residents living in the vicinity of the proposed KMC area, the public health assessment found a potential for stress-related effects on resident health, well-being, and quality of life associated with noise, effects on cultural resources and setting, relocation of residents, withdrawal of grazing lands, and resident concern for ongoing effects of mining under both Proposed Action. The potential health impact of noise and resident relocation would be moderate; all other health impacts for proposed KMC area residents would be minor. Noise impacts generally would be related to blasting, which would affect a limited number of residences. Blasting occurs approximately 20 to 30 times per month. Noise and vibration impacts would not be expected to exceed federal regulations, and would not be considered capable of producing injury or property damage but could cause annoyance depending on the distance to the receptor.

Although the potential health impacts of relocation of residents would be moderate, it should be noted that future relocation under the Proposed Action would involve a maximum of eight residences under 8.1 million tpy coal production and up to six residences under 5.5 million tpy coal production. Based on the PWCC relocation procedures described in Section 3.18.3.1, resident relocation also has a potential to be beneficial and could result in reduced stress for those residents who would prefer new homes with improved amenities, those relocated near their customary use areas, and those who might prefer to reside near other family members. The potential health impacts of withdrawal of grazing lands would be minor. Future withdrawal of grazing lands would affect up to six grazing permittees who would be compensated for the loss of or reduction in their grazing areas.

For residents living in the vicinity of the proposed KMC, the public health assessment found the potential for minor health impacts on sensitive sub-populations associated with $PM_{2.5}$ with mine operations, even though ambient air quality criteria would be met. The assessment noted that while small increases in ambient $PM_{2.5}$ concentrations could lead to minor negative health effects associated with existing health conditions of sensitive subpopulations, most cases of health problems among the affected population are associated with causes unrelated to $PM_{2.5}$ exposure.

The public health assessment also noted concerns among some residents living in the vicinity of the proposed KMC for the effects of continued mining activities under the Proposed Action. It was concluded that whether the community concerns were related to direct health effects associated with mine operations or indirect effects such as visual disturbances, conflicts with traditional lifestyles (see Section 3.18.3.1 for a discussion of Native American traditional values), or public safety related to nearby mining, these factors potentially could cause emotional stress, which would lead to an impact on overall well-being and/or psychosocial health.

The Proposed Action would result in potential major positive public health effects for workers (and their families) holding NGS and proposed KMC direct, indirect, and induced jobs. There also would be potential for moderate to minor adverse health effects associated with mining-related noise, effects on cultural resources and the traditional setting, relocation of residents, withdrawal of grazing lands, and concern for ongoing effects of mining for residents living in the vicinity of the proposed KMC, but these effects by themselves would not constitute a disproportionately high and adverse impact for those residents who are part of the environmental justice population on the Navajo Nation.

3.19.4.3.2.5 Cultural Resources

Potential effects on cultural resources that may result from the Proposed Action would be resolved through implementation of the stipulations in the proposed KMC Programmatic Agreement. As noted in the preceding public health and HHRA, some individuals could be affected more than others by effects on cultural resources. Within the vicinity of the proposed KMC, there would be potential for environmental justice impacts related to the long-term occupancy by families in the area, and the potential that cultural resources important to them may be affected by mining.

A National Historic Preservation Act Section106 process was conducted during the Black Mesa Archaeological Project which occurred during the 1980s. Approved processes for burials, traditional cultural properties, sacred and ceremonial sites, and unidentified finds have been in place in PWCC's approved Surface Mining Control and Reclamation Act of 1977 permits for more than 20 years. Measures to resolve potential adverse effects on archaeological sites, historical-period resources, and TCPs would include avoidance, monitoring, or resolving direct and indirect adverse effects through the development of a Historic Properties Treatment Plan. This plan would be developed in consultation with the Tribes, Bureau of Indian Affairs, State Historic Preservation Office, and other consulting parties to the programmatic agreement. Treatment of historic properties would be completed prior to the commencement of any applicable mine-related activity. The potential impact of effects on cultural resources would be minor based on the avoidance and provisions of the proposed KMC Programmatic Agreement. Consequently, no disproportionately high and adverse cultural resources-related effects on environmental justice populations would be anticipated for the Proposed Action.

3.19.4.3.2.6 Socioeconomic Conditions

Under the Proposed Action, the economic, fiscal and sociocultural benefits associated with the proposed KMC would continue through 2044 (Section 3.18.4.3). The direct, indirect and induced employment benefits within the project study area would accrue predominantly to Navajo and Hopi workers and their families, allowing these workers to remain on their respective reservations and support extended families. Fiscal benefits of the Proposed Action would accrue throughout the Navajo Nation and Hopi Reservation, supporting a continuation of tribal services and related employment. As noted in Section 3.18.4.3, these beneficial effects would be considered major for the Navajo Nation and Hopi Tribe.

Economic and fiscal benefits would be the highest under the Proposed Action 8.1 million tpy coal production. Under the 5.5 million tpy coal production, total proposed KMC-related employment would be 31 percent lower (Section 3.18.3.1). The lower number of proposed KMC-related direct jobs and many indirect and induced jobs under the 5.5 million tpy coal production (compared to existing employment levels) likely would involve workers residing in the Kayenta, Tuba City, Shonto, Forest Lake, and Pinon chapters, and on the Hopi Reservation. In the case of the Hopi, the lower KMC-related payments to the Tribe associated with the 5.5 million tpy coal production likely would result in the need to reduce tribal services and employment, absent a comparable new source of revenue. The social effects of these job losses would be compounded by the fact that many Navajo and Hopi workers reportedly support an extended family household. Given that equivalent employment opportunities would not be available in the affected areas, these impacts likely would be long-term as described in Section 3.18.4.3.

There would be fewer jobs associated at the proposed KMC under Proposed Action 5.5 million tpy coal production, compared to either existing operations or the Proposed Action 8.1 million tpy coal production. The socioeconomic effects of the differences would be adverse and accrue disproportionately to the environmental justice population in surrounding Navajo Nation communities and the Hopi Reservation. Nonetheless, the 5.5 million tpy coal production still would provide substantial employment and revenues to the two tribes, which would support tribal services and additional employment.

As noted in Section 3.19.1, factors considered in environmental justice assessments should include the "physical sensitivity of the community or population to particular impacts; the effect of any disruption on the community structure associated with the proposed action; and the nature and degree of impact on the physical and social structure of the community" (CEQ 1997). Additionally, U.S. Department of the Interior NEPA policy requires identification and evaluation of the equity of the distribution of the benefits and risks for minority and low-income populations and communities (U.S. Department of Interior 1995).

Within the environmental justice population on the Navajo Nation, residents living in the vicinity of the proposed KMC merit special consideration. See Section 3.18.3.1 for a discussion of current and historic social and cultural conditions within in the lease area.

As noted in the preceding Public Health and Human Health subsection, up to eight additional households may require relocation under the Proposed Action. To date all relocated residents have voluntarily accepted relocation or compensation (PWCC 2012 et seq.). Relocated households are given a choice of relocation or compensation, and PWCC works with relocated household to procure and prepare the homesite, construct homes and other structures, and prepare the homes for utility service. Nevertheless, given the traditional attachment of Navajo to their homesites relocation may be stressful for some households.

Raising sheep and other livestock is culturally important for some Navajo. As many as six grazing areas would be withdrawn from active use under the Proposed Action (Section 3.18.3.1). Although grazing permittees would receive compensation for use of their grazing areas during the period that the areas are withdrawn, finding replacement grazing areas is difficult and costly. This difficulty is compounded by temporary restrictions on grazing in reclaimed areas within the proposed KMC to allow reclaimed areas to recover from drought and overgrazing. It is not known when residents would be allowed to resume grazing in reclaimed areas that occupy their customary use areas. The resulting reclaimed grassland communities are intended to increase the livestock carrying capacity and improve the potential for grazing management (Office of Surface Mining Reclamation and Enforcement 2011).

Under the Proposed Action, residents living in the vicinity of the Proposed KMC, many of whom are the descendants of the residents of the area at the time mining was initiated, would continue to coexist with mining activities, resident relocations, withdrawal of grazing lands, and altered landscapes. These factors would continue to change the traditional setting and social structure. Although active mining areas are fenced and gated, many residents would continue to travel mine roads that also are used by industrial traffic and heavy equipment to get to and from their homes and grazing areas. As noted for the public health assessment, these factors contribute to concern for continued mining among some residents. For some residents, the belief that mining is incompatible with Navajo traditional values is particularly concerning.

Under the Proposed Action, benefits of the proposed KMC would accrue to mine employees and all members of the Navajo Nation and the Hopi Tribe through services and employment funded by proposed KMC lease, royalty, and other payments. The impacts in the vicinity of the proposed KMC, which have been described by the Navajo Nation Council as adversely affecting or impacting the socioeconomic and environmental interests of area residents (Title 2 Navajo Nation Code, Chapter 3, Subchapter 11, Article 5, Section 902), would fall disproportionately on residents living in the vicinity of the proposed KMC, virtually all of whom are Navajo. These effects, which would be considered direct effects of mining activities, would not impact populations beyond those residing within the vicinity of the proposed KMC.

Although the above described impacts would affect all residents living in the vicinity of the proposed KMC, for some residents, particularly those with a family member employed at the mine, more beneficial impact such as employment, replacement residences or compensation, payments for withdrawn grazing lands, and PWCC supported amenities and services including free coal, water, road maintenance, and emergency medical aid could be seen as offsetting these adverse impacts. For others, the mining activity, perceived health and safety risks, and the change in the landscape and cultural setting would not be offset by these benefits. Consequently, while economic and fiscal effects of the proposed KMC under the Proposed Action would be largely beneficial for the Navajo Nation and Hopi Tribe, direct social and cultural effects would be considered adverse and accrue disproportionately to residents living in the vicinity of the proposed KMC who are part of the environmental justice population and warrant special consideration because of their proximity to mining operations.

Within the proposed KMC area, the 5.5 million tpy coal production would correspondingly result in less traffic, fewer changes in the landscape and cultural setting, less disturbance of TCPs, fewer relocations, and withdrawals of less grazing lands. Although these impacts would be reduced as compared to the 8.1 million tpy coal production, they would still fall disproportionately on residents residing within the vicinity of the proposed KMC.

3.19.4.3.3 Transmission Systems and Communication Sites

The configuration and operation of both the WTS and STS are anticipated to remain unchanged under all action alternatives. With the exception of the southern terminus of the STS, the ROWs for both transmission lines are located away from any concentrations of populations. Future maintenance activities for the communication sites, transmission lines, and access roads would be infrequent, short duration, and localized (**Appendix 1B**). For example, transmission line structure maintenance and repair would occur on an as-needed basis; routine actions, such as vegetation clearing, would occur once every 5 years, or less frequently depending on need; repair of access roads and tower infrastructure would occur along localized sections of the lines or roads; and annual maintenance of access roads would occur once or twice a year, but equipment would move through the areas quickly. The foreseeable environmental impacts of these activities are negligible. Consequently, no adverse environmental or health impacts associated with continued operations of the WTS and STS and associated communication sites would be anticipated under any alternative Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

CEQ environmental justice guidance under NEPA states, “Where a proposed agency action would not cause any adverse environmental impacts, and therefore would not cause any disproportionately high and adverse human health or environmental impacts, specific demographic analysis may not be warranted” (CEQ 1997). Based on the conclusion that the Proposed Action and action alternatives would result in negligible environmental or health impacts associated with continued operations of the transmission systems and communications sites, specific demographic environmental justice analyses were not conducted for the transmission systems and communication sites.

3.19.4.3.4 Central Arizona Project Area of Indirect Socioeconomic Effects

In 2014, CAP water deliveries of 1,525,960 acre-feet were made to 77 customers; 50 municipal and industrial customers and 16 receiving water deliveries from Indian water allocations, which include non-tribal entities that have leased water from tribes. Deliveries for municipal and industrial use accounted for 39 percent of the total deliveries, with those deliveries accounting for 50 percent of the municipal water supply in the three counties (Central Arizona Water Conservation District [CAWCD] 2014). Water deliveries allocated to CAP-affected tribes accounted for 35 percent of the 2014 water deliveries. Non-tribal agricultural deliveries and water used in CAP’s recharge program accounted for the remaining 26 percent of deliveries (CAWCD 2014).

Changes in energy costs associated with the Proposed Action would affect water costs for CAP customers (Section 3.18.4.3), with the relative magnitude of change varying across the different categories of customers. Reclamation has no control over those costs and they would be associated with the continued operation of the NGS.

For municipal and industrial customers on long-term contracts, pumping energy costs represent approximately half of the total water rate. For many municipal and industrial customers, subsequent treatment, distribution, and system operation costs would reduce the relative effect of increased pumping costs on individual consumers. Increased costs would result in higher costs of doing business, reductions in consumer disposable income for other purposes, and higher costs for the public sector (e.g., for irrigation, public recreation and potable uses). Secondary effects of such impacts could include reductions in employment and income. Higher water costs would boost ongoing efforts towards conservation and improved irrigation efficiency.

The largest relative impact would be for users in the Agricultural Settlement Pool that pay only energy charges. The impact of the higher rates also would be substantial on agricultural interest that use water for irrigation. Because agricultural producers are not able to set the prices for their commodities, increases in production costs typically come from the bottom line (i.e., lower farm income). These factors may result in farming operations being scaled back, changes in cropping patterns, changes in the amount of land in production, or in extreme instances, could result in cessation of farming and conversion of land to other uses. As noted above, agricultural use of water represents more than one-third of the annual water deliveries by CAP.

Higher energy rates also could hamper plans for CAP-affected tribes to support future agricultural and development uses and population growth and affect their ability to reestablish traditional irrigation-based agriculture on their reservations. CAP-affected tribes also would have fewer revenues to fund tribal services.

For individual tribes and users, higher water costs could result in reductions in the quantity of water used and acreages under cultivation, changes in crops raised, and cutbacks in farm employment. As with municipal and industrial users, higher water costs also could promote conservation and efforts to improve irrigation efficiency. Higher rates for CAP water could prompt some current users to resume or increase groundwater pumping.

CAP water users would face potential indirect consequences from higher energy costs as a result of lower revenues that would accrue to the Lower Colorado River Basin Development Fund (Section 3.18.3.3). Annual revenues from surplus power sales are deposited to the Fund and then available for application to CAP's debt repayment obligation to the federal government for the capital cost of the CAP system. As a result, reductions in revenues from surplus energy sales would pose a risk for CAP's municipal and industrial subcontract users, who could face higher capital charges to fund CAWCD's repayment obligation.

Economic and social effects related to the potential increases in the pumping costs and potential changes in contributions to the Development Fund would apply broadly to all CAP customers. Due to the intensity of water use for irrigation, the relative effects on agricultural users, including those tribes with CAP water allocations that use all or parts of their allocation for agriculture, could be higher than for municipal and industrial users. Again these costs would accrue to all agricultural users of CAP water. Based on these conclusions, adverse socioeconomic effects of increases in CAP water delivery costs and potential decreases in contributions to the Development Fund would not represent a disproportionate impact on the environmental justice populations identified for this assessment.

3.19.4.3.5 Project Impact Summary – All Project Components

The assessments conducted for this EIS did not identify high and adverse air quality, water resources, ecological, or safety impacts for any population from implementation of the Proposed Action. Adverse human health and sociocultural impacts were not identified for northeastern Arizona, the majority of the Navajo Nation, or the Hopi Reservation.

Sociocultural and potential minor to moderate human health impacts were identified for residents living in the vicinity of the proposed KMC. These effects would continue to alter the traditional setting and social structure in the area. For some of these residents, employment, replacement residences or compensation, per acre payments for withdrawn grazing lands, and PWCC-supported amenities and services could be seen as offsetting these effects. For others, the mining activity, perceived health and safety risks, and the change in the landscape and cultural setting would not be offset by these benefits. These adverse impacts would not affect populations in other areas of the Navajo Nation, the Hopi Reservation, or northeastern Arizona that are not considered environmental justice populations. Consequently, residents living in the vicinity of the proposed KMC who are part of the environmental justice population on the Navajo Nation would experience disproportionately high and adverse sociocultural impacts under the Proposed Action.

The 5.5 million tpy coal production would result in lower Navajo and Hopi employment and comparable or lower revenues to the two tribes as compared to 8.1 million tpy coal production; however, employment and revenue levels would still be much higher than under the No Action Alternative. Although sociocultural effects on residents living in the vicinity of the proposed KMC would be reduced as compared to the 8.1 million tpy coal production, they would still fall disproportionately on this environmental justice population and would not affect other Navajo and Hopi, or non-environmental justice populations in northeastern Arizona. Consequently environmental justice effects would be similar for both 8.1 million tpy and 5.5 million tpy coal productions for the Proposed Action.

Users of CAP water, including CAP-affected tribes, would experience indirect effects associated with increases in pumping costs related to higher energy costs under the Proposed Action. The effects of those increases would be greatest for entities that use CAP-delivered water for agricultural purposes (including the agricultural uses of CAP-affected tribes) as pumping costs are essentially all or the majority of their costs. CAP water users would face potential further indirect effects related to lower revenues that would accrue to the Lower Colorado River Basin Development Fund, and its ability to repay CAP's debt obligation to the federal government. Because these effects would apply broadly to all CAP customers, no disproportionately high and adverse impacts to environmental justice populations would be anticipated.

3.19.4.3.6 Cumulative Effects

3.19.4.3.6.1 Navajo Generating Station

The assessments conducted for this EIS for NGS did not identify past, present, or reasonably foreseeable future activities in conjunction with activities associated with the Proposed Action that would result in other than negligible to minor environmental, human health, economic, or social effects on any population. Consequently no high and adverse cumulative impacts on identified environmental justice populations would be anticipated.

3.19.4.3.6.2 Proposed Kayenta Mine Complex

According to the assessments conducted for this EIS for the proposed KMC, past, present, and reasonably foreseeable actions in conjunction with activities associated with the Proposed Action would not result in other than negligible to minor environmental or economic effects on any population. Potentially minor to moderate public health and sociocultural effects would occur for residents living in the vicinity of the proposed KMC.

The sociocultural assessment (Section 3.18.3.1) concluded that past and present mining activities on the proposed KMC lease area, which include operations of the former Black Mesa Mine and over 40 years of operation of the Kayenta Mine, has resulted in sociocultural effects on area residents, many of whom have coexisted with mining activities and altered landscapes for decades. These impacts are due to sharing access roads with heavy industrial traffic, noise, altered landscapes, effects on cultural resources, relocation, and withdrawal of grazing lands. In combination with other factors such as poverty, population growth, and the Navajo-Hopi Land Resettlement Act, these impacts have resulted in substantial change in both the traditional setting and social structure.

The public health and sociocultural assessments noted the concern for continued mining among some residents living in the vicinity of the proposed KMC. Whether the community concerns are related to direct health effects associated with mine operations or indirect effects such as visual disturbances, changes in the traditional and cultural setting, or public safety related to nearby mining, these concerns could cause emotional stress, leading to an impact on overall well-being and/or psychosocial health. For some residents, the belief that mining is incompatible with Navajo traditional values is particularly stressful. With the exception of conflicts with traditional values, these direct effects of mining activities would accrue to residents living in the vicinity of the proposed KMC; no other populations would be affected.

Regarding reasonably foreseeable future activities in the lease area, phases 1 and 2 of the Many Mules water project would supply water to a number of households. Three further planned phases are dependent on funding.

For some residents residing within the vicinity of the proposed KMC, employment, relocation or compensation for homes; compensation for withdrawn grazing land; PWCC-provided amenities and services; and the prospect of receiving water service could be seen as offsetting these adverse effects. For others, these benefits would not be considered as offsetting the adverse effects.

Consequently, cumulative adverse sociocultural effects of past and present actions combined with the effects of the Proposed Action would disproportionately affect the environmental justice population residing within the vicinity of the proposed KMC lease area.

3.19.4.3.6.3 Central Arizona Project Area of Indirect Socioeconomic Effects

No past or present actions when considered in combination with the Proposed Action likely would appreciably affect the CAP water deliveries. The primary reasonably foreseeable factor affecting the price of water delivered to CAP customers would be potential Colorado River water shortages. Decreases in water deliveries would occur under a declared shortage on the Colorado River, such that fixed operation, maintenance, and recovery costs would need to be recovered based on a lesser quantity of water deliveries. Preliminary assessment from CAWCD estimates that rates could increase by as much as 25 percent based on Stage I shortage conditions (reduction of 320,000 acre-feet withdrawn). Additional rate increases would occur in the event of Stage II or Stage III shortage conditions. These effects would apply broadly to all CAP customers; therefore, no disproportionately high and adverse cumulative impacts to CAP area environmental justice populations would be anticipated.

3.19.4.4 Natural Gas Partial Federal Replacement Alternative

Under the Natural Gas Partial Federal Replacement (PFR) Alternative, 100 megawatts (MW) to 250 MW of power generation at NGS would be replaced by alternative power purchased from an unknown, but existing source(s). The net result of these purchases would be between 0.88 tera-watt hours (TW-hours) and 2.19 TW-hours of energy sourced from replacement sources annually The site(s) of the existing source(s) is unknown but would not be within the local study area.

3.19.4.4.1 Navajo Generating Station

The assessments for this EIS concluded that the Natural Gas PFR Alternative would result in negligible adverse impacts to air quality (all emissions would be slightly less than those associated with the Proposed Action and fall within ambient air quality standards), negligible impacts to water resources, and negligible impacts on human health. Although NGS emissions would be reduced under the Natural Gas PFR Alternative, sensitive subpopulations could experience some minor impacts due to exacerbation of existing health conditions. However, the likelihood of the impact is lower for the Natural Gas PFR Alternative than for the Proposed Action, which were determined to be minor.

There would be a small potential for impacts to cultural resources under the 3-Unit Operation, but if such impacts occurred, they would be offset by the provisions of the NGS Programmatic Agreement.

The Natural Gas PFR Alternative would result in less local economic benefit compared to the Proposed Action. For the Natural Gas PFR 2-Unit Operation, the employment reductions would be more related to the shutdown of one NGS unit than to the partial replacement of federal power. NGS-related revenues to the Navajo Nation under the Natural Gas PFR Alternative would be the same as under the Proposed Action.

The social and economic effects of reductions in employment and tribal revenues associated with the Natural Gas PFR Alternative and all reductions in NGS power would fall disproportionately on members of the Navajo Nation; however, employment and revenues would be substantially higher than the No Action Alternative.

Based on these findings, no high and adverse impacts on environmental justice populations would be anticipated from NGS and the associated facilities under the Natural Gas PFR Alternative.

3.19.4.4.2 Proposed Kayenta Mine Complex

The assessments conducted for this EIS concluded that the Natural Gas PFR Alternative would result in negligible impacts to air quality (all emissions would fall within ambient air quality standards), water quantity, and water quality. Cultural resources could be disturbed, but disturbance would be offset by the provisions of the KMC Programmatic Agreement. Particulate emissions under the Natural Gas PFR Alternative would meet national ambient air quality standards criteria.

The public health assessment and HHRA concluded that human air and soil pollutant exposure for the Natural Gas PFR Alternative would be considered acceptable and have a negligible impact on human health. Particulate emissions under the Natural Gas PFR Alternative would have little adverse effect on the health of the general population. Although proposed KMC emissions would be reduced under both Natural Gas PFR Alternative, sensitive subpopulations could experience some minor impacts due to exacerbation of existing health conditions. However, the likelihood of the impact would be even lower for the Natural Gas PFR Alterative than for the Proposed Action, which would be minor.

Employment and tribal revenues associated with the Natural Gas PFR Alternative would be lower than those associated with either the Proposed Action or existing conditions, depending on the amount of energy at NGS that would be replaced.

For residents living in the vicinity of the proposed KMC, the public health assessment identified potential health impact of noise, effects on cultural resources, relocation of residents, and withdrawal of grazing lands. Of these, health impacts of resident relocation and noise would be moderate; others would be considered minor. Fewer residents potentially would be relocated and fewer grazing areas withdrawn to accommodate mining under the Natural Gas PFR Alternative than under the Proposed Action.

Although mine-related traffic, changes in the landscape, traditional setting and social structure, disturbance of TCPs, relocations, and withdrawals of grazing lands would be lower for the Natural Gas PFR Alternative, these effects would fall disproportionately on residents living in the vicinity of the proposed KMC.

Residents living in the vicinity of the proposed KMC would continue to coexist with mining activities and altered landscapes and cultural settings. These impacts, which are seen as adverse by some, are considered direct effects of mining activities and would not impact populations beyond those residing within the vicinity of the proposed KMC.

As noted previously, proposed KMC employment would be reduced under the Natural Gas PFR Alternative, reducing potential offsetting benefits to area residents. Other PWCC-provided amenities and services would continue.

Economic and fiscal effects of the proposed KMC under the Natural Gas PFR Alternative would be considered beneficial for the Navajo Nation and Hopi Tribe. Direct sociocultural effects of the Natural Gas PFR Alternative would be considered adverse for some residents living in the vicinity of the proposed KMC and accrue disproportionately to those residents who are part of the environmental justice population and warrant special consideration because of their proximity to mining operations.

3.19.4.4.3 Central Arizona Project Area of Indirect Socioeconomic Effects

Users of CAP water, including CAP-affected tribes, would experience indirect effects associated with differences in pumping costs related to energy costs under the Natural Gas PFR Alternative compared to those under the Proposed Action (Section 3.18.4.4). Depending on the future prices of natural gas, pumping costs under the Natural Gas PFR Alternative could range from somewhat lower to substantially higher than those under the Proposed Action. The differences would be minor to major impacts to users, depending on the rates. The effects of those differences would be most pronounced for entities that use CAP-delivered water for agricultural purposes (including the agricultural uses of CAP-affected tribes) due to potential increases in pumping costs. The differences in energy costs under this alternative could affect the economic feasibility of future sales of surplus energy, which provides revenue to support to the Development Fund. At the upper end of the cost range, the additional costs could make it economically unjustifiable for CAWCD to purchase energy and power from NGS (Section 3.18.4.4).

The potential differences in pumping costs for CAP water users under the Natural Gas PFR Alternative also would result in indirect impacts to all CAP users. Higher contributions to the Lower Colorado River

Basin Development Fund could correspond to lower pumping costs, easing the debt repayment burden on CAP users. Conversely, higher rates would hamper the ability to repay CAP's debt obligation to the federal government. Because the latter effects would apply broadly to all CAP customers, no disproportionately high and adverse impacts to CAP area environmental justice populations would be anticipated under the Natural Gas PFR Alternative.

3.19.4.4.4 Project Impact Summary – All Project Components

The assessments for this EIS concluded that air quality, water resources, ecological, and safety effects of the Natural Gas PFR Alternative would be negligible for any population under either the 3-Unit Operation or 2-Unit Operation. Adverse human health and sociocultural impacts were not identified for populations in northeastern Arizona, the majority of the Navajo Nation, or the Hopi Reservation; however, human health and sociocultural impacts potentially would be minor to moderate for residents living in the vicinity of the proposed KMC. For some of these residents, potential impacts could be offset by project employment, replacement residences or compensation, per acre payments for withdrawn grazing lands, and PWCC-supported amenities and services. For others, particularly those that do not have a family member employed at the mine and/or believe that mining is not compatible with Navajo traditional values (Section 3.18.3.1), the mining activity, perceived health and safety risks, and the change in the landscape and cultural setting would not be offset by these benefits. These adverse impacts would not affect the remainder of the Navajo Nation, the Hopi Reservation, or non-environmental justice populations in northeastern Arizona. Consequently, residents living in the vicinity of the proposed KMC who are part of the environmental justice population on the Navajo Nation would experience disproportionately high and adverse sociocultural impacts under the Natural Gas PFR Alternative.

Although the Natural Gas PFR Alternative would result in a reduction in Navajo and Hopi employment and revenues compared to existing conditions, employment and revenue levels still would be much higher than under the No Action Alternative. Public health and sociocultural effects on residents living in the vicinity of the proposed KMC would be reduced under the Natural Gas PFR Alternative compared to the Proposed Action, and the reduction in effects would increase as the amount of federal replacement power increased. These effects still would fall disproportionately on this environmental justice population and would not affect the rest of the Navajo Nation, the Hopi Reservation, or the non-environmental justice populations in northeastern Arizona.

Pumping energy costs for the CAP would increase under either Natural Gas PFR Alternative. Although low natural gas prices could result in energy costs being lower than those under the Proposed Action, pumping energy costs potentially could be much higher with 250 MW of replacement energy and higher future gas prices. The higher energy costs under such conditions could affect the economic feasibility of future sales of surplus energy to support the Development Fund. These effects would apply broadly to all CAP customers; therefore, no disproportionately high and adverse impacts to CAP area environmental justice populations would be anticipated under the Natural Gas PFR Alternative.

3.19.4.4.5 Cumulative Impacts

3.19.4.4.5.1 Navajo Generating Station

According the assessments conducted for this EIS for NGS, past, present, and reasonably foreseeable activities in conjunction with activities associated with the Natural Gas PFR Alternative would result in only negligible to minor environmental, human health, economic, or social effects on any population. Consequently no high and adverse cumulative impacts on identified environmental justice populations would be anticipated.

3.19.4.4.5.2 Proposed Kayenta Mine Complex

The proposed KMC past, present, and reasonably foreseeable activities in conjunction with activities associated with the Natural Gas PFR Alternative would result in only negligible to minor environmental effects on any population. Potential public health and sociocultural effects were identified for residents living in the vicinity of the proposed KMC. The public health assessment identified potential minor to moderate health impact of noise, effects on cultural resources, relocation of residents, and withdrawal of grazing lands. Of these, impacts from noise and resident relocation would be moderate; health effects associated with disturbance of cultural resources and withdrawal of grazing lands would be minor. It is possible that fewer residents would be relocated and fewer grazing areas would be withdrawn to accommodate mining under the Natural Gas PFR Alternative than under the Proposed Action. The potential for relocations and grazing displacement would be reduced as the amount of federal energy replacement increased.

The sociocultural assessment (Section 3.18.3.1) concluded that past and present mining activities on the proposed KMC, which include operations of the former Black Mesa Mine and over 40 years of operation of the Kayenta Mine has resulted in sociocultural effects on area residents, many of whom have coexisted with mining activities and altered landscapes and cultural settings for decades. These include sharing access roads with heavy industrial traffic, noise, altered landscapes, traditional settings and social structure, effects on cultural resources, relocation, and withdrawal of grazing areas. In combination with other factors such as poverty, population growth, and the Navajo-Hopi Land Resettlement Act, these impacts have resulted in substantial change in both the traditional setting and social structure.

The public health assessment noted concern among some proposed KMC area residents for continued mining. It concluded that the community concerns related to direct health effects associated with mine operations or indirect effects (e.g., visual disturbances, loss of traditional and cultural lifestyles, or public safety related to nearby mining) potentially could cause emotional stress, leading to an impact on overall well-being and/or psychosocial health. For some residents, the belief that mining is incompatible with Navajo traditional values could result in considerable stress. These direct effects of mining activities would accrue to residents living in the vicinity of the proposed KMC. No other populations would be affected.

Regarding reasonably foreseeable future activities in the lease area, phases 1 and 2 of the Many Mules water project would supply water to a number of households. The remaining three phases are dependent on funding.

For some residents residing within the vicinity of the proposed KMC, employment, relocation or compensation for homes, compensation for withdrawn grazing land, PWCC-provided amenities and services, and the prospect of receiving water service would offset these adverse impacts. For others, these benefits would not be consider as offsetting the adverse effects.

Consequently, cumulative adverse sociocultural effects of past and present actions combined with effects associated with the Natural Gas PFR Alternative would disproportionately affect the environmental justice population residing within the vicinity of the proposed KMC.

3.19.4.4.5.3 Central Arizona Project Area of Indirect Socioeconomic Effects

Cumulative effects on the CAP customers under the Natural Gas PFR Alternative would be similar to those associated with the Proposed Action with the exception that pumping costs could be lower or higher depending on natural gas prices, which could exacerbate or moderate the economic effects of declared Colorado River water shortages for CAP customers. These effects would apply to all CAP customers; therefore, no disproportionately high and adverse impacts to CAP area environmental justice populations would occur under the Natural Gas PFR Alternative.

3.19.4.5 Renewable Partial Federal Replacement Alternative

Under this alternative, assumes NGS output would be curtailed to lower the federal share of NGS energy by between 100 MW and 250 MW of generating capacity over a 14-hour period, that duration generally corresponding to the period of high commercial and residential demand and the availability of renewable generation in the southwest. A corresponding amount of energy would be supplied by power purchased from non-NGS sources, with a stipulation that the generating source(s) be renewable technology. The net result would be between 0.51 TW-hours and 1.28 TW-hours of energy sourced from renewable sources annually with the replacement power providing the equivalent of between 58.3 megawatt hours (MW-hours) and 145.8 MW-hours per hour over the course of a 24-hour period. That power would be acquired through a power purchase agreement with one or more existing, but presently unidentified, sources of renewable energy. Energy deliveries from the renewable sources would be monitored and curtailment at NGS scheduled to achieve the necessary reduction in NGS production and associated reductions in coal combustion. NGS curtailment would not necessarily be concurrent with the scheduled delivery of energy from the renewable sources to the CAP. Non-concurrent curtailment provides flexibility to optimize operations of NGS, while assuring achievement of the established levels of emission reductions, and maintaining the availability of surplus energy from NGS at about the same quantities as under the Proposed Action.

3.19.4.5.1 Navajo Generating Station

The assessments conducted for this EIS concluded that the Renewable PFR Alternative would result in negligible impacts to air quality (all emissions would be slightly less than those associated with the Proposed Action and fall within ambient air quality standards), water resources, and human health for the general population.

There would be a small potential for impacts to cultural resources under the 3-Unit Operation, but such impacts would be mitigated by the provisions of the NGS Programmatic Agreement.

The Renewable PFR Alternative would result in lesser employment at NGS compared to the Proposed Action. NGS-related revenues to the Navajo Nation under the Renewable PFR Alternative would be the same as under the Proposed Action.

The social and economic effects of reductions in employment and tribal revenues associated with the Renewable PFR Alternative under the 2-Unit Operation compared to existing conditions would fall disproportionately on Navajo Nation employees; however, employment and revenues still would be substantial. Positive socioeconomic benefits associated with increased revenue and continued and future employment opportunities at NGS would result in major health benefits for the affected workers and their families. Implementation of the Renewable PFR Alternative would reduce the magnitude of those positive impacts, and the magnitude of reduction would increase commensurate with the amount of federal energy replaced.

Based on these assessments, no disproportionate high and adverse impacts on environmental justice populations would be anticipated from NGS under the Renewable PFR Alternative.

3.19.4.5.2 Proposed Kayenta Mine Complex

The assessments conducted for this EIS concluded that the Renewable PFR Alternative would result in negligible impacts to air quality (all emissions would fall within ambient air quality standards), water quantity, and water quality. Cultural resources could be disturbed, but disturbance would be offset by the provisions of the NGS Programmatic Agreement. The public health assessment and HHRAs conducted for the Renewable PFR Alternative concluded that human air and soil pollutant exposure would be considered acceptable and have negligible effects on human health.

Employment and tribal revenues associated with the Renewable PFR Alternative would be lower than those associated with either the Proposed Action or existing conditions. The Renewable PFR Alternative would support 45 to 114 fewer jobs than the Proposed Action, depending on the amount of energy at NGS that would be replaced. Proposed KMC-related revenues would be reduced by 5 to 13 percent compared to the Proposed Action, depending on the amount of energy at NGS that would be replaced.

Potential health impacts of noise, effects on cultural resources, relocation of residents, and withdrawal of grazing lands, which all were moderate to minor under the Proposed Action, would be lower under the Renewable PFR Alternative. It is possible that fewer residents would be relocated and fewer grazing areas withdrawn to accommodate mining under the Renewable PFR Alternative than under the Proposed Action. The potential for relocations and grazing displacement would be reduced as the amount of federal energy replacement increased.

Although mine traffic, changes in the landscape, disturbance of TCPs, relocations, and withdrawals of grazing lands would continue at reduced rates for the Renewable PFR Alternative, they still would fall disproportionately on residents living in the vicinity of the proposed KMC, compounding the impacts of job losses described above.

Residents living in the vicinity of the proposed KMC would continue to coexist with mining activities and altered landscapes, traditional settings, and social structure. These impacts would fall disproportionately on residents residing within the vicinity of the proposed KMC, virtually all of whom are Navajo. These effects, which are considered direct effects of mining activities, would not impact populations beyond those residing within the vicinity of the proposed KMC.

As noted previously, proposed KMC employment would be reduced under the Renewable PFR Alternative, reducing potential offsetting benefits to area residents. Other PWCC-provided amenities and services would continue.

Economic and fiscal effects of the proposed KMC under the Renewable PFR Alternative would be considered positive for the Navajo Nation and Hopi Tribe. Direct sociocultural effects would accrue disproportionately to residents living in the vicinity of the proposed KMC who are part of the environmental justice population and warrant special consideration because of their proximity to mining operations

3.19.4.5.3 Central Arizona Project Area of Indirect Socioeconomic Effects

Pumping energy costs for the CAP would increase under the Renewable PFR Alternative. Costs associated with curtailment and firming would account for the majority of the increases, particularly as the amount of energy provided by the Renewable PFR rises. The likely impacts of those increases would comprise a minor to major impact for users. The higher energy costs under this alternative could affect the economic feasibility of future sales of surplus energy, which would continue to provide revenue to support to the Development Fund. These effects could make it economically unjustifiable for CAWCD to purchase energy and power from NGS (Section 3.18.4.4).

The substantially higher pumping costs for CAP water users under the Renewable PFR Alternative would result in greater indirect affects to all CAP users. Lower contributions to the Colorado River Basin Development Fund, would hamper the Fund's ability to repay CAP's debt obligation to the federal government. These effects would apply broadly to all CAP customers; therefore, no disproportionately high and adverse impacts to CAP area environmental justice populations would be anticipated under the Renewable PFR Alternative.

3.19.4.5.4 Project Impact Summary – All Project Components

The assessments conducted for this EIS did not identify high and adverse air quality, water resources, ecological, or safety impacts for any population that would result from implementation of the Renewable PFR Alternative; therefore, impacts would be negligible. Adverse human health and sociocultural impacts were not identified for northeastern Arizona, the majority of the Navajo Nation, or the Hopi Reservation, but sociocultural impacts and potential moderate to minor human health impacts were identified for residents living in the vicinity of the proposed KMC. For some of these residents, potential impacts could be offset by project employment, replacement residences or compensation, per acre payments for withdrawn grazing lands, and PWCC-supported amenities and services. For others, particularly those that do not have a family member employed at the mine and/or believe that mining is not compatible with Navajo traditional values, the mining activity, perceived health and safety risks, and the change in the landscape, traditional setting, and social structure would not be offset by these benefits. These impacts would not affect the remainder of the Navajo Nation, the Hopi Reservation, or non-environmental justice populations in northeastern Arizona. Consequently, residents living in the vicinity of the proposed KMC who are part of the environmental justice population on the Navajo Nation would experience disproportionately high and adverse social and cultural impacts under the Renewable PFR Alternative.

Although the Renewable PFR Alternative would result in a reduction in Navajo and Hopi employment and revenues compared to existing conditions, employment and revenue levels would still be much higher than under the No Action Alternative. Public health and sociocultural effects on residents living in the vicinity of the proposed KMC would be reduced under the Renewable PFR Alternative compared to the Proposed Action. Although the reduction in effects would increase as the amount of federal replacement power increased, they would still fall disproportionately on this environmental justice population and would not affect non-environmental justice populations in northeastern Arizona.

The substantially higher pumping costs for CAP water users under the Renewable PFR Alternative would result in greater indirect affects to all CAP users, including lower contributions to the Lower Colorado River Basin Development Fund. These effects would apply broadly to all CAP customers; therefore, no disproportionately high and adverse impacts to CAP area environmental justice populations would be anticipated under the Renewable PFR Alternative.

3.19.4.5.5 Cumulative Impacts

3.19.4.5.5.1 Navajo Generating Station

According the assessments conducted for this EIS for NGS, past, present, and reasonably foreseeable activities in conjunction with activities associated with the Renewable PFR Alternative would not result in other than negligible to minor adverse environmental, human health, economic, or social effects on any population. Consequently no high and adverse cumulative impacts on identified environmental justice populations would be anticipated.

3.19.4.5.5.2 Proposed Kayenta Mine Complex

According to the assessments conducted for this EIS for the proposed KMC, past, present, and reasonably foreseeable activities in conjunction with activities associated with the Renewable PFR Alternative would not result in other than negligible to minor environmental effects on any population. Potentially adverse public health and sociocultural effects would occur for residents living in the vicinity of the proposed KMC. The public health assessment identified potential health impacts of noise, effects on cultural resources, relocation of residents, and withdrawal of grazing lands. Of these, health impacts of noise and resident relocations would be major, and health effects of associated with disturbance of cultural resources and withdrawal of grazing lands would be considered minor. Fewer residents possibly would be relocated and fewer grazing areas withdrawn to accommodate mining under the Renewable PFR Alternative than under the Proposed Action. The potential for relocations and grazing displacement would be reduced as the amount of federal energy replacement increased.

The sociocultural assessment (Section 3.18.3.1) concluded that past and present mining activities on the proposed KMC lease area, which included operations of the former Black Mesa Mine and over 40 years of operation of the Kayenta Mine, has resulted in sociocultural effects on area residents, many of whom have coexisted with mining activities and altered landscapes and cultural settings for decades. These include sharing access roads with heavy industrial traffic, noise, altered landscapes, effects on cultural resources, relocation, and withdrawal of grazing areas. In combination with other factors such as poverty, population growth, and the Navajo-Hopi Land Resettlement Act, these impacts have resulted in substantial change in both the traditional setting and social structure.

The public health assessment noted concern for continued mining among some proposed KMC area residents. It concluded that the community concerns related to direct health effects associated with mine operations or indirect effects (e.g., visual disturbances, loss of traditional and cultural lifestyles, or public safety related to nearby mining) potentially could cause emotional stress, leading to an impact on overall well-being and/or psychosocial health. For some residents, the belief that mining is incompatible with Navajo traditional values could result in considerable stress. These direct effects of mining activities would accrue to residents living in the vicinity of the proposed KMC. No other populations would be affected.

Regarding reasonably foreseeable future activities in the lease area, phases 1 and 2 of the Many Mules water project would supply water to a number of households. The remaining three phases are dependent on funding.

For some residents living in the vicinity of the proposed KMC, employment, relocation or compensation for homes, compensation for withdrawn grazing land, PWCC-provided amenities and services, and the prospect of receiving water service would offset these other impacts. For others, these benefits would not be considered as offsetting the adverse effects.

Consequently, cumulative adverse sociocultural effects of past and present actions combined with effects associated with the Renewable PFR Alternative would disproportionately affect the environmental justice population residing within the vicinity of the proposed KMC.

3.19.4.5.5.3 Central Arizona Project Area of Indirect Socioeconomic Effects

Cumulative effects on the CAP system under the Renewable PFR Alternative would be similar to those associated with the Proposed Action, with the exception that the higher pumping costs for this alternative would exacerbate the economic effects of declared Colorado River water shortages for CAP customers. These effects would apply to all CAP customers; therefore, no disproportionately high and adverse impacts to CAP area environmental justice populations would be anticipated under either Renewable PFR Alternative.

3.19.4.6 Tribal Partial Federal Replacement Alternative

Under this alternative, power and energy would be purchases from photovoltaic solar facility(ies) located on the lands of one or more affected tribes. Energy from the PV solar facility(ies) would be dedicated to meet a portion of CAP demands during daylight hours (e.g., 12 hours a day, delivering between 100 MW to 250 MW to the CAP during the midday. The net result would be between 0.33 TW-hours and 0.84 TW-hours of energy sourced from the Tribal photovoltaic solar facility(ies) annually with the replacement solar power providing an average of between 38 MW-hours and 94.9 MW-hours per hour over a typical 24-hour period. Energy deliveries from the photovoltaic source(s) would be monitored and NGS curtailment scheduled to achieve the necessary reduction in NGS production and associated reductions in coal combustion. NGS curtailment would not necessarily be concurrent with the scheduled delivery of energy from the photovoltaic sources to the CAP. Non-concurrent curtailment provides flexibility to optimize operations of NGS, while assuring achievement of the established levels of emission reductions, and maintaining the availability of surplus energy from NGS at about the same quantities as under the Proposed Action.

Construction of a new photovoltaic generation site on tribal land would require the commitment of land, estimated at between 1,200 and 3,00 acres, and would result in new surface disturbance at a location subject to evaluation in a subsequent NEPA action. Sites selected for installation of a photovoltaic generation project would be subject to U.S. trust responsibilities. Record searches, and interviews with tribal members would be required to identify TCPs located within and near the proposed site development area as part of site feasibility reviews and pre-construction surveys. If the project were constructed and owned by a Tribe, the revenues from electrical generation would accrue directly to the Tribe.

Tribal Employment Rights Ordinance requirements likely would result in substantial employment opportunities for tribal members during construction and operations of the photovoltaic generation facility. Jobs created by the facility would generate additional indirect and induced jobs, some of which also likely would be filled by members of the host tribe. Site lease revenues or revenues generated by energy sales from the photovoltaic facility could support tribal services and infrastructure, at the discretion of the host tribe's governing body.

3.19.4.6.1 Navajo Generating Station

The assessments conducted for this EIS concluded that the Tribal PFR Alternative would result in negligible impacts to air quality (all emissions would be slightly less than those associated with the Proposed Action and fall within ambient air quality standards), no impacts to water resources, and negligible impacts on human health for the general population.

There would be a small potential for impacts to cultural resources under the 3-Unit Operation, but if such impacts were to occur, they would be mitigated by the provisions of the NGS Programmatic Agreement.

The Tribal PFR Alternative would result in as many as 50 fewer jobs at NGS compared to the Proposed Action.

NGS-related revenues to the Navajo Nation under the Tribal PFR Alternative would be the same as under the Proposed Action.

The social and economic effects of reductions in employment and tribal revenues associated with the Tribal PFR Alternative compared to existing conditions would fall disproportionately on Navajo Nation employees; however, employment and revenues still would be substantial. Positive socioeconomic benefits related to increased revenue and continued and future employment opportunities at NGS would result in major health benefits for the affected workers and their families. Implementation of the Tribal PFR Alternative would reduce the magnitude of such positive effects, and the magnitude of reduction would increase commensurate with the amount of federal energy replaced.

Based on these assessments, no high and adverse impacts on environmental justice populations would be anticipated from NGS and the associated facilities under the Tribal PFR Alternative.

3.19.4.6.2 Proposed Kayenta Mine Complex

The assessments conducted for this EIS concluded that the Tribal PFR Alternative would not result in adverse impacts to air quality (all emissions would fall within ambient air quality standards), and impacts to water quantity and quality would be negligible. Cultural resources could be disturbed, but disturbance would be mitigated by the provisions of the NGS Programmatic Agreement.

The public health and HHRA conducted for the Tribal PFR Alternative concluded that human air and soil pollutant exposure would be considered acceptable and would have a negligible impact on human health for the general population. Particulate emissions under the Tribal PFR Alternative would meet national ambient air quality standards criteria, and proposed KMC operations would have little to no effect on the health of the general population. Although proposed KMC emissions would be reduced under the Tribal PFR Alternative, sensitive subpopulations still could experience some impacts due to exacerbation of existing health conditions; however, the likelihood of the impacts would be lower for the Tribal PFR Alternative than for the Proposed Action, which were deemed to be minor.

Employment and tribal revenues associated with the Tribal PFR Alternative would be lower than those associated with either the Proposed Action or existing conditions. The Tribal PFR Alternative would support as many as 77 to 114 fewer jobs than the Proposed Action, depending on the amount of curtailment at NGS. Proposed KMC-related revenues would be reduced by 5 to 13 percent compared to the Proposed Action, depending on the amount of curtailment at NGS.

For residents living in the vicinity of the proposed KMC, the public health assessment identified potential minor to moderate health impacts of noise, effects on cultural resources, relocation of residents, and withdrawal of grazing lands. It is possible that fewer residents would be relocated and fewer grazing areas would be withdrawn to accommodate mining under the Tribal PFR Alternative than under the Proposed Action. The potential for relocations and grazing displacement would be reduced as the amount of federal energy replacement increased.

Although mine traffic, changes in the landscape, traditional setting and social structure, disturbance of TCPs, relocations, and withdrawals of grazing lands would continue at reduced rates for the Tribal PFR Alternative, they still would fall disproportionately on residents living in the vicinity of the proposed KMC, compounding the impacts of job losses described above.

Residents living in the vicinity of the proposed KMC would continue to coexist with mining activities as well as altered landscapes and cultural settings. These impacts, which are seen as adverse by some residents, would fall disproportionately on residents living in the vicinity of the proposed KMC, virtually all of whom are Navajo. These effects, which are considered direct effects of mining activities, would not impact populations beyond those residing within the vicinity of the proposed KMC.

As noted above, proposed KMC employment would be reduced under the Tribal PFR Alternative, reducing potential offsetting benefits to area residents. Other PWCC-provided amenities and services would continue.

Economic and fiscal effects of the proposed KMC under the Tribal PFR Alternative would be considered beneficial for the Navajo Nation and Hopi Tribe. Direct sociocultural effects would be considered adverse and accrue disproportionately to some residents living in the vicinity of the proposed KMC who are part of the environmental justice population and warrant special consideration because of their proximity to mining operations.

3.19.4.6.3 Central Arizona Project Area of Indirect Socioeconomic Effects

Pumping energy costs for the CAP would increase under the Tribal PFR Alternative, with energy costs potentially much higher with 250 MW of replacement energy (Section 3.18.4.6). The likely impacts of those increases would comprise a minor to major impact for users. The higher energy costs under this alternative could affect the economic feasibility of future sales of surplus energy, which provides revenue to support to the Colorado River Basin Development Fund.

The substantially higher pumping costs for CAP water users under the Tribal PFR Alternative would result in greater indirect affects to all CAP users. Lower contributions to the Colorado River Basin Development Fund, would hamper the Fund's ability to repay CAP's debt obligation to the federal government. Because these effects would apply broadly to all CAP customers, no disproportionately high and adverse impacts to CAP area environmental justice populations would be anticipated under the Tribal PFR Alternative.

3.19.4.6.4 Project Impact Summary – All Project Components

The assessments conducted for this EIS did not identify high and adverse air quality, water resources, ecological, or safety impacts for any population that would result from implementation of the Tribal PFR Alternative.

Adverse human health and sociocultural impacts were not identified for northeastern Arizona, the majority of the Navajo Nation, or the Hopi Reservation, but sociocultural impacts and potential human health impacts were identified for residents living in the vicinity of the proposed KMC. For some of these residents, potential impacts could be offset by project employment, replacement residences or compensation, payments for withdrawn grazing lands, and PWCC-supported amenities and services. For others, particularly those that do not have a family member employed at the mine and/or believe that mining is not compatible with Navajo traditional values, the mining activity, perceived health and safety risks, and the change in the landscape, traditional setting, and social structure would not be offset by these benefits. These impacts would not affect the rest of the Navajo Nation, the Hopi Reservation, or non-environmental justice populations in northeastern Arizona. Consequently, residents living in the vicinity of the proposed KMC, who are part of the environmental justice population on the Navajo Nation would experience disproportionately high and adverse sociocultural and health impacts under the Tribal PFR Alternative.

Although the Tribal PFR Alternative would result in a reduction in Navajo and Hopi employment and revenues to the two tribes compared to existing conditions, employment and revenue levels still would be much higher than under the No Action Alternative. Sociocultural and health effects on residents within the vicinity of the proposed KMC would be reduced under the Tribal PFR Alternative compared to the Proposed Action. Although the reduction in effects would increase as the amount of federal replacement power increased, they still would fall disproportionately on this segment of the environmental justice population and would not affect the rest of the Navajo Nation, the Hopi Reservation, or non-environmental justice populations in northeastern Arizona.

The higher pumping costs for CAP water users under the Tribal PFR Alternative would result in greater indirect affects to all CAP users. Lower contributions to the Colorado River Basin Development Fund would hamper the Fund's ability to repay CAP's debt obligation to the federal government. Because these effects would apply broadly to all CAP customers, no disproportionately high and adverse impacts to CAP-area environmental justice populations would be anticipated under the Tribal PFR Alternative.

3.19.4.6.5 Cumulative Impacts

3.19.4.6.5.1 Navajo Generating Station

According the assessments conducted for this EIS for NGS, past, present, and reasonably foreseeable activities in conjunction with activities associated with the Tribal PFR Alternative would result in no more than negligible to minor adverse environmental, human health, economic, or social effects on any population. Consequently no high and adverse cumulative impacts on identified environmental justice populations would be anticipated.

3.19.4.6.5.2 Proposed Kayenta Mine Complex

According to the assessments conducted for this EIS for the proposed KMC, past, present, and reasonably foreseeable activities in conjunction with activities associated with the Tribal PFR Alternative would result in no more than negligible to minor adverse environmental or economic effects on any population. Potentially adverse public health and sociocultural effects were identified for residents living in the vicinity of the proposed KMC. The public health assessment identified potential minor to moderate health impacts of noise, effects on cultural resources, relocation of residents, and withdrawal of grazing lands. It is possible that fewer residents would be relocated and fewer grazing areas would be withdrawn to accommodate mining under the Tribal PFR Alternative than under the Proposed Action. The potential for relocations and grazing displacement would be reduced as the amount of federal energy replacement increased.

The sociocultural assessment (Section 3.18.3.1) concluded that past and present mining activities on the proposed KMC, which include operations of the former Black Mesa Mine and over 40 years of operation of the Kayenta Mine, has resulted in sociocultural effects on area residents, many of whom have coexisted with mining activities and altered landscapes and cultural settings for decades. These include sharing access roads with heavy industrial traffic, noise, altered landscapes, effects on cultural resources, relocation, and withdrawal of grazing areas. In combination with other factors such as poverty, population growth, and the Navajo-Hopi Land Resettlement Act, these impacts have resulted in substantial change in both the traditional setting and social structure.

The public health assessment also noted the concern for continued mining among proposed KMC area residents. It concluded that the community concerns related to direct health effects associated with mine operations or indirect effects (e.g., visual disturbances, loss of traditional and cultural lifestyles, or public safety related to nearby mining) potentially could cause emotional stress, leading to an impact on overall well-being and/or psychosocial health. For some residents, the belief that mining is incompatible with Navajo traditional values could result in considerable stress. These direct effects of mining activities would accrue to residents living in the vicinity of the proposed KMC. No other populations would be affected.

Regarding reasonably foreseeable future activities in the lease area, phases 1 and 2 of the Many Mules water project would supply water to a number of households. The remaining three phases are dependent on funding.

For some residents living in the vicinity of the proposed KMC, employment, relocation or compensation for homes, compensation for withdrawn grazing land, PWCC-provided amenities and services, and the prospect of receiving water service would offset these other impacts. For others, these benefits would not be considered as offsetting the adverse effects.

Consequently, cumulative adverse sociocultural effects of past and present actions combined with effects associated with the Tribal PFR Alternative would disproportionately affect the environmental justice population residing within the vicinity of the proposed KMC.

3.19.4.6.5.3 Central Arizona Project Area of Indirect Socioeconomic Effects

Cumulative effects to the CAP system under the Tribal PFR Alternative would be similar to those associated with the Proposed Action, with the exception that the higher pumping costs for this alternative would exacerbate the economic effects of any declared Colorado River water shortages for CAP customers. These effects would apply to all CAP customers; therefore, no disproportionately high and adverse impacts to CAP-area environmental justice populations would be anticipated under the Tribal PFR Alternative.

3.19.4.7 No Action

In the absence of the Proposed Action, major socioeconomic effects would occur throughout the study area.

3.19.4.7.1 Navajo Generating Station and the Proposed Kayenta Mine Complex

Under the No Action Alternative, operation of NGS and the Kayenta Mine would cease by December 23, 2019. Decommissioning and reclamation plans, policies and requirements for NGS are described in Section 2.3.1.1 and **Appendix 1B**. As required in the 1969 Lease, the land would be restored as closely as possible to original condition where the surface of any leased land has been modified or improved. Decommissioning and reclamation plans, policies and requirements for the Kayenta and former Black Mesa mines are described in Section 2.3.1.2, and **Appendix 1B**. Based on the conclusions of the assessments conducted for this EIS, the potential for air quality, water quality, health and safety, and cultural impacts would be associated with decommissioning and reclamation activities at NGS and the Kayenta and former Black Mesa mines, which would be temporary and short-term.

In contrast, implementation of the No Action Alternative and the resultant cessation of operations at these facilities would result in major, widespread, and long-lasting socioeconomic impacts for the Navajo Nation and Hopi Tribe. These impacts would directly and indirectly affect NGS and Kayenta Mine workers, Navajo and Hopi tribal services and employment, Navajo and Hopi households, and businesses. The loss of jobs and income and the reductions in revenues paid to the tribes would result in major adverse effects, given persistently high unemployment and poverty among on-reservation Navajo and Hopi, the importance of the revenues paid to the tribal governments in supporting tribal employment and the provision of services on a reservation wide basis. The importance of the jobs, income, and revenues is underscored by the lack of any currently identified or reasonably foreseeable new industrial or commercial development that offers prospects to offset the losses.

Implementation of the No Action Alternative would result in the loss of up to 3,090 jobs in the region (Section 3.18.4.7). The Navajo Nation and Hopi Tribe are the single largest employers on their respective reservations. They, along with local governments and public education providers, would see combined reductions in net revenues of more than $58.5 million per year, which is equivalent to more than 23 percent of the combined annual general fund revenues of the two tribes. Foregone revenues to the Navajo under Lease Amendment No. 1 (or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1) would be the equivalent of another 18 percent loss in general fund revenues. The losses would be particularly severe for the Hopi Tribe for which mining related revenues account for more than 80 percent of the tribal general fund that supports the tribe's executive, legislative, and judicial functions as well as various services provided to its members. Both tribes would continue to receive various federal grants and contract funds and operate their respective enterprise activities, but those grants and contract funds generally are dedicated to sustaining the enterprises and providing specific programs (e.g., housing); consequently, they are unavailable to meet general government expenses.

Given that 86 percent of NGS employees are Native American (primarily Navajo), 96 percent of the Kayenta Mine workforce is Native American (primarily Navajo), the majority of employees of the tribal services supported by NGS and Kayenta Mine-related revenues are either Navajo or Hopi, and many of the indirect and induced jobs supported by the two facilities are held by either Navajo or Hopi workers, the No Action Alternative-related job losses would disproportionately affect the Navajo Nation and Hopi Tribe.

Although reductions in Tribal employment likely would occur across the two reservations, direct and induced job losses would mainly affect the Navajo chapters near NGS and the Kayenta Mine and the Hopi Reservation.

Positive benefits on health associated with the income and community stability that the NGS and Kayenta Mine provide to the local community also would be eliminated. The elimination of the jobs and income would result in widespread unemployment, emigration of Navajo and Hopi families or wage earners in search of employment, and a reduced material standard of living for many Navajo and Hopi families. These effects would be compounded by the fact that many Navajo and Hopi wage earners support an extended family. These effects could have potentially dramatic indirect effects because general health and well-being are closely correlated to community socioeconomic conditions. In general, communities with low income potential and high unemployment have much poorer health statistics and reduced access to health care.

The scholarship and other charitable and service initiatives supported by NGS and PWCC likely would end over time. PWCC-provided amenities such as free coal and water, road maintenance, and the Kayenta Mine Emergency Clinic would be terminated.

Closure of the Kayenta Mine, would begin to bring a sense of resolution to Navajo and Hopi who view mining and burning of coal on tribal lands and the use of tribal water for mining as incompatible with their respective traditional values. This would be in part because mining and coal-fired electric power generation activities would cease and reclamation would occur 25 years sooner than under all action alternatives.

Under the No Action Alternative, no additional residents living in the vicinity of the proposed KMC would be relocated, no additional grazing lands would be withdrawn, and substantially fewer, if any, TCPs, places, or landscapes that have cultural and religious significance would be disturbed. The land would be reclaimed, but not returned to its pre-mining condition because the reclamation program is designed to increase the livestock carrying capacity and improve the potential for grazing management. The concerns of residents regarding previous relocations, grazing withdrawals, disturbance of cultural resources, and removal of artifacts and burial sites could persist.

The No Action Alternative would result in major social and economic impacts related to reductions in employment, income and local government revenues throughout northeastern Arizona. These social, economic and associated public health impacts would accrue disproportionately to the Navajo Nation and Hopi Tribe, which are the environmental justice populations identified for this EIS. The adverse social and economic effects of the No Action Alternative would be greater than those under any of the action alternatives and would accrue disproportionately to a larger environmental justice population than the social and economic effects of any of the action alternatives.

The NGS transmission system is an established part of the western U.S. transmission grid and supports reliability and delivery of power throughout the region, well beyond the power generated by the NGS. Therefore, under the No Action Alternative it is likely that that one, several, or all of the land owners/managers of the transmission line rights-of-way and communication site leases would renew some portion of the facilities to keep the power grid performing as expected.

In the event it is determined that some or all of the transmission systems and communication site ROWs are not renewed, a lengthy study and permitting process would need to occur before any decommissioning is initiated due to the essential and integral nature of these facilities with the western electric grid. As noted in Section 2.3.3, up to 4,826 acres within and alongside the transmission system corridors could be temporarily disturbed if the entirety of the transmission systems and communication sites were decommissioned and removed.

3.19.4.7.2 Central Arizona Project Area of Indirect Socioeconomic Effects

A decision denying federal approval of the actions necessary to allow operation of NGS and the proposed KMC to continue would necessitate actions on the part of CAWCD to secure an alternative source(s) of electrical power and energy to operate the CAP system. Based on the analysis conducted for this EIS, pumping energy costs under the No Action Alternative could be between 23 percent less costly and 21 percent more costly compared to the costs under the Proposed Action, depending on market conditions and future prices of natural gas. Due to the uncertainty regarding natural gas prices, future energy rates under No Action may be more variable over time than under the Proposed Action. **Table 3.18-78** presents the comparative energy pumping rates and energy costs for the No Action and the Proposed Action Alternatives.

Surplus energy sales and revenues to support the Colorado River Basin Development Fund would cease under the No Action Alternative, regardless of whether pumping energy costs were higher or lower than those under the Proposed Action. Compensating for the loss of such revenues would require adjustments by CAP to fund debt service. The loss of surplus revenue sales could increase pumping energy rates on the order of $10 to $15 per acre-foot (Section 3.18.4.7).

Indirect socioeconomic effects of the No Action Alternative would depend on the ultimate cost of power and pumping costs to the CAP. Higher power costs, coupled with the costs resulting from cessation of contributions to the Colorado River Basin Development Fund, would represent a major socioeconomic impact for CAP customers. Conversely, substantially lower energy costs could compensate for the cessation of contributions to the Development Fund, resulting in minor impacts. In either case, these effects would apply broadly to all CAP customers. No disproportionately high and adverse impacts to CAP area environmental justice populations would be anticipated under the No Action Alternative.

3.19.4.7.3 No Action Impact Summary – All Project Components

Implementation of the No Action Alternative would result in cessation of emissions from operations at NGS and the Kayenta Mine. Based on the conclusions of the assessments conducted for this EIS, the potential for air quality, water quality, health and safety and cultural impacts associated with decommissioning and reclamation activities at NGS and the Kayenta and former Black Mesa mines, would be temporary and short-term.

Effects of mining, including relocation, withdrawal of grazing lands, disturbance of cultural resources, and conflicts with Navajo and Hopi traditional values, would effectively cease after 2019. Some traffic and noise effects would continue through the decommissioning and reclamation period, but at greatly reduced levels.

Economic effects would include the loss of over 3,000 total existing jobs in the region, many of which are currently held by Navajo and Hopi workers. Economic effects also would include the loss of more than $54.8 million in combined revenues annually for the two tribes, which would be equivalent to more than 23 percent of the combined annual general fund revenues of the two tribes. Foregone revenues to the Navajo under Lease Amendment No. 1 (or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1) would be the equivalent of another 18 percent loss in general fund revenues. The losses would be particularly severe for the Hopi Tribe for which mining related revenues account for more than 80 percent of its general fund. The reductions in tribal revenues would in turn reduce services and employment on the two reservations, which would be major, long-term adverse impacts for the two tribes. Employment losses would have corresponding social effects and potentially result in relocation for affected Navajo and Hopi families or wage earners. These economic and social impacts would be considered high and adverse and would accrue disproportionately to the Navajo Nation and Hopi Tribe, which are environmental justice populations identified for this EIS.

Although indirect socioeconomic effects of the No Action Alternative could range from major to minor for CAP customers, including CAP-affected Indian tribes, the effects would apply broadly to all CAP customers. Consequently no disproportionately high and adverse impacts to CAP area environmental justice populations would be anticipated.

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Section 3.20

Indian Trust Assets

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Acronyms and Abbreviations

1969 Lease	Navajo Project Indenture of Lease
BART	Best Available Retrofit Technology
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BM&LP Railroad	Black Mesa and Lake Powell Railroad
BO	Biological Opinion
CAP	Central Arizona Project
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CO_2	carbon dioxide
Co-tenants	Salt River Project, Los Angeles Department of Water and Power, Arizona Public Service, NV Energy, and Tucson Electric Power Company
Development Fund	Lower Colorado River Basin Development Fund
EIS	Environmental Impact Statement
ERA	Ecological Risk Assessment
ESA	Endangered Species Act of 1973
HHRA	Human Health Risk Assessment
Indian trust asset	Indian Trust Asset
km	kilometer
KMC	Kayenta Mine Complex
kV	kilovolt
kW	kilowatt
MW	megawatt
N-Aquifer	Navajo Aquifer
NEPA	National Environmental Policy Act of 1969, as amended
NGS	Navajo Generating Station
NGS Participants	U.S. (Reclamation), Salt River Project, Los Angeles Department of Water and Power, Arizona Public Service, NV Energy, and Tucson Electric Power Company
NHPA	National Historic Preservation Act
NNEPA	Navajo Nation Environmental Protection Agency
NO_2	nitrogen dioxide
NO_X	nitrogen oxide
OSMRE	Office of Surface Mining Reclamation and Enforcement
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 microns or less
PFR	Partial Federal Replacement
PWCC	Peabody Western Coal Company
Reclamation	U.S. Bureau of Reclamation
ROW	Right-of-way

SO_2	sulfur dioxide
SRP	Salt River Project Agricultural Improvement and Power District
STS	Southern Transmission System
tpy	tons per year
U.S.	United States
USEPA	U.S. Environmental Protection Agency
WTS	Western Transmission System

Contents

3.20 Indian Trust Assets 3.20-1
3.20.1 Regulatory Framework 3.20-1
3.20.1.1 Consultation and Public Involvement 3.20-2
3.20.2 Study Areas 3.20-2
3.20.2.1 Proposed Action and Action Alternatives 3.20-2
3.20.2.2 Cumulative 3.20-3
3.20.3 Affected Environment 3.20-3
3.20.3.1 Navajo Nation 3.20-3
3.20.3.2 Hopi Tribe 3.20-3
3.20.3.3 Kaibab Band of Paiute Indians 3.20-3
3.20.3.4 Moapa Band of Paiute Indians 3.20-3
3.20.3.5 CAP-affected Tribes 3.20-4
3.20.4 Environmental Consequences 3.20-4
3.20.4.1 Issues 3.20-4
3.20.4.2 Impact Methodology 3.20-5
3.20.4.3 Proposed Action 3.20-5
3.20.4.4 Natural Gas PFR Alternative 3.20-15
3.20.4.5 Renewable Partial Federal Replacement Alternative 3.20-21
3.20.4.6 Tribal Partial Federal Replacement Alternative 3.20-26
3.20.4.7 No Action 3.20-31
3.20.5 References 3.20-36

List of Tables

Table 3.20-1 Tribes with CAP Water Allocations 3.20-4

3.20 Indian Trust Assets

Indian trust assets are "…'legal interests' in 'assets' held in 'trust' by the Federal Government for federally recognized Indian tribes or individual Indians" (United States [U.S.] Bureau of Reclamation [Reclamation] 1994). Trust assets may include lands, minerals, hunting and fishing rights, water rights, and instream flows. Cultural and paleontological resources located on Indian trust lands also may be Indian trust assets in some specific situations. The U.S., with the Secretary of the Interior as the Trustee, holds many assets in trust for Indian tribes or Indian individuals (Reclamation 1993a). The U.S. Bureau of Indian Affairs (BIA) further states, "In several cases discussing the trust responsibility, the Supreme Court has used language suggesting that it entails legal duties, moral obligations, and the fulfillment of understandings and expectations that have arisen over the entire course of the relationship between the U.S. and the federally recognized tribes" (BIA 2016).

3.20.1 Regulatory Framework

The U.S. has a trust responsibility to protect and maintain rights reserved by or granted to Indian tribes and individuals by treaties, statutes, and executive orders. These rights are sometimes further interpreted through court decisions and regulations. This trust responsibility requires federal agencies, including Reclamation, to take all actions reasonably necessary to protect trust assets (Reclamation 1993a). The Secretary of Interior must approve actions involving and affecting Indian trust assets. The Secretary has delegated that responsibility to the Bureau of Indian Affairs (BIA) (Reclamation 1994). The BIA has authority over rights-of-way (ROWs) on Indian lands according to 25 Code of Federal Regulations (CFR) Part 169 including subpart 112 (monetary compensation for ROW over or across Indian Land); over leasing on Indian land for housing, economic development, and other purposes according to 25 CFR Part 162; and over leasing of tribal and allotted lands for mineral development according to 25 CFR Parts 211 and 212. The BIA also enforces reclamation on lands mined prior to the passage of Surface Mining Control and Reclamation Act.

The Office of Surface Mining Reclamation and Enforcement (OSMRE) is the federal regulatory authority for reviewing proposed mining plans, issuing permits, and regulating compliance for surface coal mining and reclamation operations on Indian Lands (Section 1.5.1). The Bureau of Land Management (BLM) is responsible for approvals for all operations on Indian coal leases, including exploration, mining, and operations under 43 CFR Part 3480. BLM is responsible for the approval of Resource Recovery and Protection Plans for coal operations under 43 CFR Part 3482.

According to OSMRE Directive 979, which sets forth policies and procedures the agency follows to ensure that actions comply with Indian trust asset responsibilities OSMRE "personnel must ensure that bureau actions identify, conserve, and protect lands and other resources that the Department holds in trust for federally recognized Indian tribes." The directive also states that OSMRE must consult with Indian Tribes and the BIA for actions with potential impacts on trust lands or trust resources and requires OSMRE to "Respect Indian tribal self-government and sovereignty, honor tribal treaty and other rights, and strive to meet the responsibilities that arise from the unique legal relationship between the Federal Government and Indian tribal governments" (OSMRE 2013).

According to the Kayenta Mine Permit Renewal Environmental Assessment, "The primary statutes governing the leasing of Indian coal assets for the benefit of an Indian tribe or nation are the Indian Mineral Leasing Act of 1938 and the Indian Mineral Development Act of 1982. An American Indian Coal Lease is obtained by direct negotiation with Indian tribal authorities, but is subject to approval and administration by the United States Department of the Interior. The authority by which coal reserves that are Indian trust assets are leased is described in 25 U.S. Code Section 396a and concerns leases of unallotted lands for mining purposes. It states the following: "On or after May 11, 1938, un-allotted lands within any Indian reservation or lands owned by any tribe, group, or band of Indians under federal jurisdiction, except those specifically excepted from the provisions of Sections 396a and 396g of this title, may, with the approval of the Secretary of the Interior, be leased for mining purposes, by authority of the tribal council or other authorized spokesmen for such Indians, for terms not to exceed 10 years and as long thereafter as minerals are produced in paying quantities" (OSMRE 2011).

The Navajo Nation is working toward assuming primacy to implement and enforce the Surface Mining Control and Reclamation Act on trust lands and it is anticipated that the Navajo Nation will assume primacy in 2017. Navajo Nation primacy would not affect the actions that are the subject of this EIS because the Navajo Nation program must be as stringent as, or more stringent than, the rules under the OSMRE program.

3.20.1.1 Consultation and Public Involvement

National Environmental Policy Act (NEPA) procedures for Reclamation require the agency to conduct a public involvement program designed to elicit an appropriate level of input from Indian persons and entities at all stages of the NEPA compliance process (Reclamation 2012). Section ITA 4.B. – Public Involvement of the Indian Trust Chapter: Assessment of Impact's on Indian trust assets (Reclamation 1993b), states that, "…Public involvement should be used to: (i) assist to identify potentially affected ITAs and assess potential impacts; (ii) provide potentially affected Indian people with information about the actions being studied; and (iii) involve potentially affected Indian communities in the decision making process. The public involvement program for actions potentially affecting ITAs will include consultation with interested and affected individuals, organizations, agencies, tribal governments, and other governmental entities having jurisdictional responsibilities for the assets."

Section 1.10 of this EIS identifies past Reclamation government-to-government consultations with affected tribes in conjunction with this project. Government-to-government tribal consultations will continue to occur at key stages of the project, as requested by tribal governments. Section 1.11 describes the Public Scoping process undertaken for this EIS, including the information provided prior to and during the scoping meetings.

3.20.2 Study Areas

3.20.2.1 Proposed Action and Action Alternatives

The Navajo Generating Station (NGS) is located entirely within the boundaries of the Navajo Nation. Consequently, the study area for potential effects on Indian trust assets includes the Navajo Nation with a focus on the areas within and surrounding the NGS and the Black Mesa and Lake Powell (BM&LP) Railroad.

The proposed Kayenta Mine Complex (KMC) is located entirely within the boundaries of the Navajo Nation and the Hopi Tribe; therefore, the study area for potential effects on Indian trust assets includes the Navajo Nation and Hopi Tribe with a focus on the areas surrounding and within the proposed KMC.

The Southern Transmission System (STS) ROW includes 3,913 acres of Navajo Nation trust land and does not cross other Indian lands. The Western Transmission System (WTS) ROW includes 54.5 acres of Navajo Nation land and 138 acres of Kaibab Paiute trust land. On the Moapa Paiute Indian Reservation within the BLM administered Moapa Corridor, the WTS is located within a 341-acre ROW issued by BLM. The study area for transmission systems and communication sites includes affected trust lands of these three tribes.

The Indian trust asset assessment for the Central Arizona Project (CAP) focuses on the 10 tribes with CAP water allocations (i.e., CAP-affected tribes). These include the Ak-Chin Indian Community, Fort McDowell Yavapai Nation, Gila River Indian Community, Pascua Yaqui Tribe, Salt River Pima-Maricopa Indian Community, San Carlos Apache Tribe, Tohono O'odham Nation, Tonto Apache Tribe, White Mountain Apache Tribe, and Yavapai-Apache Nation.

3.20.2.2 Cumulative

Given the influences of past and present actions and reasonably foreseeable actions on the affected Indian trust assets and the location and influences of the Proposed Action and alternatives, the study areas for the cumulative assessment are the same as those described for the Proposed Action and action alternatives.

3.20.3 Affected Environment

3.20.3.1 Navajo Nation

The Navajo Nation is a federally recognized Indian tribe whose reservation covers 12.5 million acres within New Mexico, Utah, and Arizona. The reservation initially was established by treaty in 1868 and has been expanded by Executive Orders in 1884, 1900, and 1930. The affected environment for Navajo Nation Indian trust assets includes those trust assets that may be affected by the Proposed Action or action alternatives. The majority of these assets are located within the northwest portion of the Navajo Nation, in Arizona. These assets include, but are not limited to, water, lands, minerals, and hunting. The project components that may potentially affect Indian trust assets include the NGS (including associated facilities and the BM&LP Railroad), the proposed KMC, and the transmission systems and communication sites.

Portions of the Navajo Nation are located within the Upper Colorado River Basin watershed in Arizona. Portions of the Little Colorado River watershed are located within the Navajo Nation, as well. The Navajo Nation has not yet been adjudicated a right to Upper Colorado River water, nor have water rights to the Little Colorado River watershed been adjudicated.

3.20.3.2 Hopi Tribe

The Hopi Tribe is a federally recognized Indian tribe whose reservation was established in 1882, by Executive Order. The original reservation covered 2.5 million acres in Arizona. Today, the Hopi Reservation occupies 1.5 million acres including Moenkopi. Moenkopi is a 97 square-mile portion of the Hopi Reservation separated from and located west of the main reservation. Both the main reservation and Moenkopi are surrounded by the Navajo reservation. The assets potentially affected by the Proposed Action or action alternatives include water, land, minerals, and hunting. The project component that potentially may affect Hopi Indian trust assets is the proposed KMC.

Portions of the Little Colorado River watershed are located on lands of the Hopi Tribe. The Hopi Tribe has not yet been adjudicated a right to Little Colorado River water.

3.20.3.3 Kaibab Band of Paiute Indians

The Kaibab Band of Paiute Indians is a federally recognized Indian tribe whose reservation was established by Executive Orders in 1913 and 1917. The reservation encompasses approximately 121,000 acres in Arizona, with its northern boundary coinciding with the Arizona-Utah boundary. Land is the only trust asset potentially affected by the Proposed Action or action alternatives. The project component that potentially may affect the Kaibab Band of Paiute Indians is the WTS, which crosses through the Kaibab Paiute trust lands. Additionally, one communication site is located on the Kaibab Paiute Reservation at Pipe Spring.

3.20.3.4 Moapa Band of Paiute Indians

The Moapa Band of Paiute Indians is a federally recognized tribe whose reservation consists of 71,954 acres located in Nevada. Originally 2 million acres were set aside in 1874 for the Moapa River Indian Reservation, but the area was reduced to 1,000 acres in 1876. In 1980, 70,000 acres were added. Land is the only trust asset potentially affected by the Proposed Action or action alternatives. The project component that potentially may affect the Moapa Band of Paiute Indians is the WTS, which crosses through the Moapa River Indian Reservation on federal land administered by the BLM.

3.20.3.5 CAP-affected Tribes

There are 10 federally recognized Indian tribes in Arizona that have received allocations of Colorado River and/or CAP water, some of which have been obtained through water settlements. These tribes are identified in **Table 3.20-1**. Water rights are the only trust asset potentially affected by the Proposed Action or action alternatives.

Table 3.20-1 Tribes with CAP Water Allocations

Tribe / Reservation	County	Reservation Land Area (acres)	Annual CAP Water Allocation (acre-feet)	Obtained through Water Settlement
Ak-Chin Indian Community	Pinal	21,840	75,000 [1] (up to 85,000 if available)	Yes
Fort McDowell Yavapai Nation	Maricopa	24,680	18,233	Yes
Gila River Indian Community	Maricopa and Pinal	371,933	311,800	Yes
Pascua Yaqui Tribe	Pima	892	500	No
Salt River Pima-Maricopa Indian Community	Maricopa	52,729	39,200	Yes
San Carlos Apache Tribe	Gila and Graham	1,853,841	30,845 [2]	Yes
Tohono O'odham Nation	Pinal and Pima	2,774,370	74,000	Yes, except for 8,000 af
Tonto Apache Tribe	Gila	85	128	No
White Mountain Apache	Navajo, Gila, Apache	1,664,972	25,000	Yes
Yavapai-Apache Nation	Yavapai	640	1,200	No
TOTALS	—	**6,765,982**	**575,906**	

3.20.4 Environmental Consequences

3.20.4.1 Issues

Indian trust assets in the areas surrounding the NGS include water resources and land, particularly with regard to impacts from disturbance and uses. Indian trust assets within and adjacent to the proposed KMC also include water and land as well as minerals and hunting. Therefore, Indian trust assets for the Navajo Nation and Hopi Tribe include land, water, minerals, and hunting.

Land is the only Indian trust assets for the transmission systems and communication sites; therefore, it would be the only trust asset for the Kaibab Band of Paiute Indians and the Moapa Band of Paiute Indians.

Water is the Indian trust assets for the CAP, particularly with regard to water rights for the CAP-affected tribes.

3.20.4.2 Impact Methodology

For the assessment of potential effects of the Proposed Action and alternatives on Indian trust assets, sections of this EIS that evaluated water, land and land use, minerals, and tribal revenues were reviewed to identify affected Indian trust assets and potential impacts on those assets. Due to the tribal-centric nature of Indian trust assets, discusssions regarding the resources evaluated are organized by tribe rather than by project component.

3.20.4.3 Proposed Action

Under the Proposed Action, NGS would continue operating through 2044, and decommissioning activities would occur through 2045. For purposes of the analysis of impacts to the trust assets described above, future NGS operations would include either 3-Unit Operation or 2-Unit Operation and essentially be consistent with historical operations, including the use of coal supplied by the proposed KMC and transported by the BM&LP Railroad, use of water from Lake Powell for cooling, ash disposal both in the on-site disposal landfill and sold for off-site use, and periodic overhauls. The transmission systems and communication sites would continue to be operated, maintained, and repaired on an as-needed basis. Periodic routine inspections would continue to occur.

3.20.4.3.1 Navajo Nation

Under the Proposed Action, surface lands would be leased from the Navajo Nation for the NGS site, overland conveyor, and portions of the transmission systems and communication sites. The lease amendment has been negotiated between SRP (on behalf of the NGS Participants) and the Navajo Nation; if approved by the Secretary of the Interior, it would be considered consistent with the Department of the Interior's trust responsibilities for Indian trust assets.

Under the terms of Lease Amendment No. 1 (or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1), the Navajo Nation would realize substantial increases in payments from the NGS Co-tenants (Section 3.18.4.3). For the 3-Unit Operation, the changes would yield a 1,400 percent increase in payments compared to current lease payments. Under the 2-Unit Operation, the additional payments would be scaled back based on a rated capacity of 1,500 megawatts (MW) for the two remaining operational generating units; therefore, the net increase would be nearly 1,000 percent. Total NGS-related payments to the Navajo Nation from 2020 to 2044 would be an estimated $1.075 billion under the Proposed Action 3-Unit Operation and $793 million under the 2-Unit Operation.

The projected $43 million in annual payments accruing to the Navajo Nation under the 3-Unit Operation would represent nearly a 15 percent increase in the tribe's annual general revenues over historical conditions. Under the 2-Unit Operation, future annual revenues to the Navajo Nation of $31.7 million would represent an increase of nearly 11 percent in the Navajo Nation's annual general revenues over historical conditions.

3.20.4.3.1.1 Water

Navajo Nation water trust assets that potentially would be affected by the Proposed Action include groundwater located beneath the NGS used at the proposed KMC for mining operations. The groundwater used at the proposed KMC would primarily be N-Aquifer water.

Water diverted from Lake Powell and surface water within the Little Colorado River are not Indian trust assets for the proposes of this assessment. As noted in Chapter 1.0, Arizona holds an Upper Colorado River Basin annual apportionment of 50,000 acre-feet of Colorado River water. The Navajo Nation has not been adjudicated a right to Upper Colorado River Basin water. In approving the 1969 Lease and subsequent Lease Amendment No. 1, the Navajo Nation has not given up any separate claim of right to use water from the Upper Colorado River Basin from Arizona's share on the Navajo Reservation.

Consequently, water diverted and used by NGS pursuant to the 1969 Lease, as amended, and the renewed Water Service Contract, is not an Indian trust asset for purposes of this assessment.

As part of the 1969 Lease, the Navajo Nation agreed that NGS could consumptively use 34,100 acre-feet per year from Arizona's share of the Upper Colorado River Basin apportionment. Section 15 of the 1969 Lease sets forth this provision, which includes an agreement by the Navajo Nation that use of water on Navajo lands in the Upper Basin of Arizona would not reduce the availability of 34,100 acre-feet per year for use by NGS. Reclamation's water service contract with SRP (on behalf of the NGS Participants) does not preclude the Navajo Nation from asserting a claim for water rights uses in Arizona. Under the Proposed Action, pursuant to Lease Amendment No. 1, Section 15 would remain in effect and the NGS Participants would continue to divert and use water pursuant to a renewed Water Service Contract with Reclamation through 2044, plus decommissioning. The NGS Co-tenants hold a certificate of water right issued by the Arizona Department of Water Resources for use of Arizona's Upper Colorado River Basin apportionment at NGS. Impacts to surface water resulting from operation of NGS under the Proposed Action are described in Section 3.7.4.2, Water Resources.

As noted earlier, the Navajo Nation also has not yet been adjudicated a right to Little Colorado River water; therefore, it is not considered to be a Navajo Nation Indian trust asset for purposes of this assessment. The Little Colorado River watershed encompasses all proposed KMC components. The Coal Mine, Dinnebito, and Moenkopi washes emanate in or near the Kayenta Mine permit area and flow southwestward as tributaries to the Little Colorado River. Impacts to these surface waters from the Proposed Action are discussed in the Section 3.7.4.2, Water Resources.

Prior to construction of the NGS, the depth of the N-Aquifer at the plant site was approximately 900 feet below ground surface. As noted in Section 3.7.3.2, recharge from Lake Powell is anticipated to cause the N-Aquifer to rise 1 to 2 feet per year for the next 50 to 100 years, when hydraulic equilibrium would be reached. At that point, the N-Aquifer would be approximately 700 to 766 feet below ground surface or more at the plant site, and approximately 824 feet below ground surface or more at the dry ash disposal area. As noted in Section 3.7.4.2, groundwater monitoring and site inspections are part of existing site management. Implementation of both a Groundwater Protection Plan and a Perched Water Dewatering Plan would monitor and address any leakage problems that arise. Prior to decommissioning NGS, measures would be implemented consistent with the Groundwater Protection Plan, Perched Water Dewatering Plan, and Resource Conservation and Recovery Act requirements, including Phase I and II Environmental Site Assessments (and remediation as required), to ensure the groundwater quality has not been impaired. A long-term monitoring plan for groundwater quality, consistent with USEPA's Coal Combustion Residuals rule, also would be implemented (Section 3.7, and **Appendix 1B**). Based on the findings of Section 3.7.4.2, no impacts to Navajo Nation water trust assets would result from Proposed Action operations at NGS.

At the proposed KMC, water withdrawals from the N-Aquifer would continue at essentially the same rate for the Proposed Action 3-Unit Operation and 2-Unit Operation. Compliance with Surface Mining Control and Reclamation Act regulations and the approved Kayenta Mine permit would continue to form the basis for water management and monitoring at the Kayenta Mine. The regulatory program guides baseline water resources characterization; assessment of potential impacts; and the design, construction, and operation of water controls to address protection of the hydrologic balance. The Navajo Nation would be compensated for these withdrawals in the form of water fees. Future fee rates for use of water from the N-Aquifer would substantially increase revenues over those that historically have been received by the Navajo Nation.[1] Mine-related pumping due to the Proposed Action would create predicted N-Aquifer drawdowns and would result in increases in pumping lift ranging from zero to a

[1] An increase in water rates, retroactive to 2015, is pending approval by the Hopi Tribal Council and the Secretary of the Interior. Details of the new rate have not been released.

maximum of 3.7 percent over current levels at affected communities. The median value would be 0.7 percent (Section 3.7.5.2).

There would be no changes to N-Aquifer water quality as a result of mining activities at the proposed KMC (Section 3.7.4.2). Effects on stream baseflows would be none to negligible, depending on the stream. Similarly, the potential impacts to discharges at N-Aquifer springs from the Proposed Action would be none to negligible.

Based on the predicted results, these effects would comprise negligible to minor impacts on Navajo Nation water trust assets from Proposed Action pumping, decommissioning, and reclamation at the proposed KMC.

3.20.4.3.1.2 Land

Navajo Nation land trust assets affected by the Proposed Action would include the Navajo Nation trust lands leased by the NGS Co-tenants for the NGS and its associated facilities, the BM&LP Railroad, the trust lands leased by PWCC that would be included in the proposed KMC, and portions of the transmission systems and communication sites that fall within the Navajo Nation. No infrastructure changes would occur to the BM&LP or the transmission systems and communication sites that fall within the Navajo Nation. Maintenance and operations of the BM&LP or the transmission systems and communication sites would be ongoing.

Under the Proposed Action, 3,485 acres of surface would be leased from the Navajo Nation for the NGS site, 67 acres for the overland conveyor, and 4,297 acres for portions of the transmission systems and communication sites located on Navajo Nation tribal trust land. Compensation for the leased lands is included under the terms of Lease Amendment No. 1 (or would be included in a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1).

Upon closure, land disturbed at NGS would be restored as closely as possible to original condition where the surface of any leased land has been modified or improved, as required by the 1969 Lease and Lease Amendment No. 1. Decommissioning of the NGS would entail compliance with the Groundwater Protection Plan, Perched Water Dewatering Plan, Phase I and II Environmental Site Assessments, and USEPA's Coal Combustion Residual Rule, (Section 3.7.4.2 and **Appendix 1B**). Consequently, no negative impacts to Navajo Nation land trust assets would be anticipated from Proposed Action NGS operations, decommissioning, or reclamation.

Under the Proposed Action, the former Black Mesa Mine and Kayenta Mine permit areas would be combined into one permit of 62,930 acres and the combined area would be called the KMC. Of that total, Navajo Nation has surface and 100 percent of the mineral rights to 22,930 acres, surface and 50 percent of the mineral rights to 33,863 acres, and 50 percent of the mineral rights to 6,137 acres. The proposed KMC would have a life-of-mine plan equivalent to the proposed life of the NGS and would continue supplying coal to the NGS through the year 2044. OSMRE approvals to mine would be subject to 5-year permit renewals. No new mining would occur at the former Black Mesa mine area. The support facilities located in the former Black Mesa mine area currently used to support mining at the Kayenta Mine would continue in use through 2044.

Future mining under the Proposed Action 3-Unit Operation would involve the N-10, N-11E, and J-21W areas as well as portions of the N-9, J-19, and J-21 areas. Under the Proposed Action 2-Unit Operation, future mining would not occur in the N-10 area. The Navajo Nation would be compensated for use of the land within the proposed KMC permit area through royalty payments, as described in the following minerals subsection.

Under the Proposed Action 3-Unit Operation, all or parts of six grazing areas would be withdrawn to accommodate mining. Some areas currently withdrawn for mining may be released for grazing following reclamation. Under the 2-Unit Operation, all or parts of five grazing areas would be withdrawn. The relocation and compensation process is described in Section 3.13.3.2. Grazing permit holders whose lands would be withdrawn would receive compensation for loss of use.

Mined land would be reclaimed pursuant to the approved reclamation plan and existing lease agreements. PWCC would restore the land with equal or greater forage productivity than pre-mining conditions (Section 3.14) or for other approved uses including wildlife habitat and cultural plants. After reclamation is determined satisfactory by the OSMRE and BIA, and following the release of bonds, control of the surface use would revert to the Navajo Nation. Negligible to minor impacts to Navajo Nation land trust assets would be anticipated under Proposed Action operations, decommissioning, and reclamation at the proposed KMC.

3.20.4.3.1.3 Minerals

Based on the findings of Section 3.4, Mineral Resources, there is a low probability that commercially extractable minerals are present in the vicinity of the NGS and a low probability that commercially extractable minerals other than coal are present in the vicinity of the proposed KMC. Therefore coal is the only Navajo Nation mineral trust asset that would be affected by the Proposed Action.

The volume of coal that would be mined in the 2020 to 2044 timeframe under the Proposed Action would depend on the implementation of 3-Unit Operation or 2-Unit Operation at NGS. A 3-Unit Operation would require delivery of approximately 8.1 million tons per year (tpy) of coal, and a 2-Unit Operation would require 5.5 million tpy. The PWCC life-of-mine plan (PWCC 2012 et seq.) anticipates that there would be adequate coal to meet NGS generation requirements from 2020 through 2044 (Section 2.3.1.2, **Table 2-6**). PWCC would not exhaust its previously granted right to mine 670 million tons of coal under either Proposed Action operation (Section 1.3).

Under the coal lease agreements, the Navajo Nation and Hopi Tribe would receive combined annual royalty and bonus payments of approximately $46.4 million per year and estimated total payments of over $1.16 billion over the period from 2020 to 2044 under the 8.1 million tpy coal production. Under the 5.5 million tpy coal production, estimated annual and total payments would be almost $33 million and $787 million, respectively. Approximately 67 percent of these revenues would accrue to the Navajo Nation. These revenues would not be sensitive to fluctuations in interest rates and energy commodity prices and would escalate in response to general inflation. Although Indian trust coal assets would be consumed under the Proposed Action, the compensation received by the tribe would be considered beneficial. The compensation, existing lease agreements, permits, and ROWs were negotiated between PWCC and the Navajo Nation, with BIA oversight; therefore, they are consistent with the U.S. Department of the Interior's trust responsibilities for Indian trust assets. BLM also monitors mining operations and reviews production reports and royalty payments to ensure compliance with lease provisions according to 43 CFR 3480 Subpart 3485 and to perform its trust responsibility over the mineral resources it is charged with overseeing. Consequently, no impacts to Navajo Nation mineral trust assest would be anticipated that would result in a reduction of their value under the Proposed Action.

3.20.4.3.1.4 Hunting

The Navajo Nation has rights to continue hunting on its lands outside the leased area for NGS and outside active mining areas on the proposed KMC. Although active mining areas would be withdrawn from hunting, reclaimed mining areas would be available for these uses. In some cases, the vegetation mix on reclaimed lands would be different than predisturbance conditions, resulting in negligible to minor impacts to these Indian trust hunting assets.

3.20.4.3.2 Hopi Tribe

3.20.4.3.2.1 Water

Hopi water trust assets that potentially may be affected by the Proposed Action includes groundwater, principally the N-Aquifer water used at the proposed KMC for mining operations. As is the case with the Navajo Nation, the Hopi Tribe has not been adjudicated a right to Little Colorado River water; consequently, Little Colorado River water is not considered an Indian trust asset for purposes of this assessment. The Little Colorado River watershed encompasses all of the existing mine components. The Coal Mine, Dinnebito, and Moenkopi washes emanate in or near the Kayenta Mine permit area and flow southwestwardly, as tributaries to the Little Colorado River. Impacts to these surface waters from the Proposed Action are discussed in detail in Section 3.7.4.2, Water Resources.

At the proposed KMC, water withdrawals from the N-Aquifer would continue at the same rate as under the Proposed Action. The Hopi Tribe would receive compensation in the form of water fees. Increased fee rates for use of water from the N-Aquifer are in the process of being negotiated. If approved, revenues would increase substantially over those historically received by the Hopi Tribe. Mine-related pumping due to the Proposed Action would create predicted N-Aquifer drawdowns and would result in increases in pumping lift ranging from zero to a maximum of 3.7 percent over current levels at affected communities. The median value would be 0.7 percent (Section 3.7.5.2). Based on the predicted results, these effects would comprise negligible to minor groundwater impacts from Proposed Action pumping.

No changes in N-Aquifer water quality would be anticipated as a result of mining activities. Effects on stream baseflows would be none to negligible, depending on the stream. Similarly, the potential impacts to discharges at N-Aquifer springs from the Proposed Action operation would be none to negligible.

Based on the conclusions of the water resources assessment (Section 3.7) negligible to minor impacts on Hopi water trust assets would be anticipated from Proposed Action operations, decommissioning, or reclamation at the proposed KMC.

3.20.4.3.2.2 Land

Hopi land trust assets that potentially may be affected by the Proposed Action include the Hopi trust lands leased by PWCC that would be included in the proposed KMC. This includes 6,137 acres for which the Hopi Tribe holds the surface interest and 50 percent of the mineral interests. No new mining would occur at the former Black Mesa mine area. The support facilities located in the former Black Mesa mine area currently being used to support mining at the Kayenta Mine would continue in use through 2044. The proposed KMC would have a life-of-mine plan equivalent to the proposed life of the NGS and would supply coal to the NGS through the year 2044. OSMRE approvals to mine would be subject to 5-year permit renewals. Future mining of Hopi coal under the Proposed Action would involve the J-21W area. Mining in the J-21 coal resource area would progress onto Hopi-owned surface after 2020; Hopi-owned surface is designated as coal resource area J-21W. The Hopi Tribe would be compensated for use of the land within the proposed KMC permit area through royalty payments as described in the following mineral subsection.

Mined land would be reclaimed pursuant to the approved reclamation plan and existing lease agreements. PWCC would restore the land with equal or greater forage productivity than pre-mining conditions (Section 3.14) or for other approved uses including wildlife habitat and cultural plants. After satisfactory reclamation is determined by the OSMRE and BIA, and following the release of bonds, control of Hopi land surface use would revert to the Hopi Tribe. Consequently, negligible to minor impacts to Hopi land trust assets would be anticipated under the Proposed Action from operations, decommissioning, or reclamation at the Proposed KMC.

3.20.4.3.2.3 Minerals

Based on the findings of Section 3.4, Mineral Resources, there is a low probability that commercially extractable minerals other than coal are present in the vicinity of the proposed KMC. Consequently, Hopi mineral trust assets that may be affected by the Proposed Action would be limited to coal. Hopi coal resources associated with the Proposed KMC include the 6,137 acres identified above as land trust assets, and those associated with an additional 33,863 acres, all of which are located within the former Joint Use Area for which the Hopi Tribe holds 50 percent of the mineral interests.

The volume of coal that would be mined at the proposed KMC in the 2020 to 2044 timeframe under the Proposed Action would depend on the implementation of 3-Unit Operation or 2-Unit Operation at NGS. A 3-Unit Operation would require delivery of approximately 8.1 million tons of coal per year, and a 2-Unit Operation would require 5.5 million tpy. PWCC would not exhaust the right to mine 670 million tons of coal located on the proposed KMC under either Proposed Action operation. Un-mined coal reserves would remain.

Under the coal lease agreements, the Hopi Tribe would receive approximately 33 percent of the combined annual royalty and periodic bonus payments described for the Navajo Nation (Section 3.20.4.3.1). These revenues would not be sensitive to fluctuations in interest rates and energy commodity prices and would escalate in response to general inflation. Although coal trust assets would be consumed under the Proposed Action, the compensation received by the tribe would be considered beneficial. The compensation, existing lease agreements, permits, and ROWs were negotiated between PWCC and Hopi Tribe, with BIA oversight; therefore, they are considered consistent with the U.S. Department of the Interior's trust responsibilities for Indian trust assets. BLM also monitors mining operations and reviews production reports and royalty and bonus payments to ensure compliance with lease provisions according to 43 CFR 3480 Subpart 3485, and perform its trust responsibility over the mineral resources it is charged with overseeing.

Consequently, no impacts to mineral trust assets would be anticipated that would result in a reduction of their value for the Hopi Tribe under the Proposed Action.

3.20.4.3.2.4 Hunting

The Hopi Tribe has rights to continue hunting on its lands outside active mining areas on the proposed KMC. Although active mining areas would be withdrawn from hunting, reclaimed mining areas would be available for these uses. In some cases, the vegetation mix on reclaimed lands would be different than predisturbance conditions, resulting in negligible to minor impacts to these hunting trust assets.

3.20.4.3.3 Kaibab Band of Paiute Indians

Kaibab Band of Paiute Indians trust assets that potentially may be affected by the Proposed Action includes 138 acres for the WTS and 0.06 acre for a communicati ons site on tribal trust land. The easement for the WTS was granted in 1972 for a one-time fee, allowing its use as long as its use is for the purpose of permitting the economical operation and maintenance of the WTS. The communications site is under a separate permit, for which the Tribe receives an annual payment. There would be no change in the easement's use or in ongoing operation, maintenance, and repair activities under the Proposed Action. Therefore, there would be no impacts to land trust assets.

3.20.4.3.4 Moapa Band of Paiute Indians

Moapa Band of Paiute Indians trust assets that potentially would be affected by the Proposed Action include 341 acres for the WTS. The easement was reserved by the U.S. prior to creation of the Moapa River Indian Reservation and is administered by the BLM, which is responsible for providing the Moapa Band of Paiute Indians with annual compensation. There would be no change in the easement's use or in ongoing operation, maintenance, and repair activities under the Proposed Action. Therefore, there would be no impacts to land trust assets.

3.20.4.3.5 CAP-affected Tribes

Water rights are the only Indian trust asset potentially affected by the Proposed Action for the CAP-affected tribes. The water rights held by tribes that received CAP water through water settlements, which are held in trust by the federal government, are considered Indian trust assets.

As noted in Chapter 1.0, the CAP system delivers water from the Colorado River to Arizona tribes holding Colorado River water entitlements but whose reservations are not located along the river. NGS provides the power that makes CAP water a feasible alternative to groundwater pumping. In addition, revenues from the sale of the federal share of NGS power that is not used to operate the CAP pumps are deposited to the Lower Colorado River Basin Development Fund (Development Fund). Development Fund revenues are credited against Central Arizona Water Conservation District's annual repayment obligation to the federal government (Section 3.18.3.3). Pursuant to the Arizona Water Settlement Act, any funds remaining in the Development Fund are used for the payment of fixed operation, maintenance, and replacement charges associated with the delivery of CAP water to Arizona Native American tribes and other statutory purposes (Section 3.18.3.3). To the degree that increases in the cost of generating NGS power reduce the marketability of surplus NGS power, revenues to the Development Fund could decrease.

The Proposed Action would not affect the water rights of those tribes having received CAP water entitlements as a result of water settlements, which are held in trust by the federal government. CAP water entitlements of other tribes with water service contracts with the Secretary of the Interior that are not Indian trust assets, also would not be affected. The delivery of the contracted CAP water entitlements would continue to be governed by the availability of CAP water and the priority schedules associated with the tribes' water settlement and contract terms (Section 3.18.4.3).

Increases in the cost of CAP water and reductions in the availability of revenues for the Development Fund could affect the tribes' decisions regarding whether or not it would be economically viable to utilize their CAP water rights and contracted CAP water entitlements. Many tribes utilize their CAP water for irrigation purposes, making it difficult to absorb the higher cost of water to the same degree that municipal and industrial users that are able to pass on water costs to a larger number of end users, such as utility customers. For those tribes that lease their CAP water to other users, increased water costs due to higher CAP pumping costs would be less of an issue. See Section 3.18.4.3 for additional discussion of impacts from the Proposed Action on the use of CAP water.

3.20.4.3.6 Project Impact Summary – All Project Components

Environmental programs and compliance with regulatory requirements at NGS (e.g., Coal Combustion Residuals regulations) and implementation of the Groundwater Protection Plan, Perched Water Dewatering Plan, Phases I and II Environmental Site Assessments (and remediation as required), and USEPA's Coal Combustion Residuals rule would protect Navajo Nation water trust assets at these sites. Ultimately, plant closure, materials disposition, and plant site reclamation would be conducted as described in the decommissioning description (**Appendix 1B**) implemented pursuant to applicable laws and regulations.

Proposed Action effects on Navajo Nation and Hopi Tribe water trust assets including the N-Aquifer and other groundwater resources at the proposed KMC would be negligible to minor at all locations, based on continued compliance with Surface Mining Control and Reclamation Act regulations and the approved Kayenta Mine permit. The Navajo Nation and Hopi Tribe would be compensated for water used in KMC operations, decommissioning, and reclamation.

Land trust assets potentially affected by the Proposed Action would include Navajo Nation trust lands associated with the NGS lease amendment, and Navajo Nation and Hopi Tribe trust lands associated with the proposed KMC. The NGS Lease Amendment No. 1 was negotiated between NGS and the Navajo Nation. The Navajo Nation would receive increased compensation for continued use of the land under the terms of the lease. If approved by the Secretary of the Interior, Lease Amendment No. 1 would be considered consistent with the U.S. Department of the Interior's trust responsibilities for Indian trust assets. Although moderate land use impacts associated with mining activities would be anticipated, the Navajo Nation and Hopi Tribe would be compensated through mineral royalty payments for the use of land associated with mining activities on the proposed KMC. Residents within mined areas would be relocated or compensated for their residences, and grazing permittees would be compensated for any land withdrawn for mining purposes.

Land disturbed at NGS would be restored as closely as possible to original condition where the surface of any leased land has been modified or improved, as required by the 1969 Lease and Lease Amendment No. 1 (or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1. Land mined at the proposed KMC would be reclaimed pursuant to the approved reclamation plan and existing lease agreements.

Coal would be the only Navajo Nation and Hopi Tribe Indian mineral trust asset affected by the Proposed Action. Compensation for coal mined at the proposed KMC would be provided to the Navajo Nation and Hopi Tribe in the form of royalty and bonus payments.

Proposed Action negative effects on Navajo Nation and Hopi Tribe land trust assets at NGS and the proposed KMC would be negligible to minor at all locations. Conversely, effects of the increase in compensation for the Navajo Nation and Hopi Tribe land and minerals would be seen as major and positive for the Navajo Nation and Hopi Tribe under the Proposed Action.

Navajo Nation rights to hunt on lands outside the leased area for NGS and the Navajo Nation and Hopi Tribe rights to hunt on their respective trust lands outside active mining areas on the proposed KMC would not be affected by the Proposed Action. Although active mining areas would be withdrawn from hunting, reclaimed mining areas would be available for these uses. The post-reclamation vegetation mix would differ from that under predisturbance conditions, resulting in improved forage for grazing and negligible to minor impacts to these Indian trust hunting assets.

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

Kaibab Band of Paiute Indians land trust assets would continue to be used for the WTS corridor. The easement for the WTS would continue to operate under the provisions of the initial agreement, compensated by the one-time fee. The communications site would continue to operate under the existing permit for which the Tribe receives an annual payment. There would be no change in the easements' use, or in ongoing operation, maintenance, and repair activities under the Proposed Action. Consequently, there would be no impacts to Kaibab Band of Paiute Indians land trust assets.

Moapa Band of Paiute Indians land trust assets potentially be affected by the Proposed Action would include land within the WTS easement reserved by the U.S. prior to creation of the Moapa River Indian Reservation. The easement is administered by the BLM, which is responsible for providing the Moapa Band of Paiute Indians with annual compensation. There would be no change in the easement's use, or in ongoing operation, maintenance, and repair activities under the Proposed Action. Consequently, there would be no impacts to the Moapa Band of Paiute Indians' land trust assets.

The Proposed Action would not affect the water rights of those tribes having received CAP water entitlements as a result of water settlements, which are held in trust by the federal government. CAP water entitlements of other tribes with water service contracts with the Secretary of the Interior that are not Indian trust assets also would not be affected. The delivery of these water rights and contracted CAP water entitlements would continue to be governed by the availability of CAP water and the priority schedules associated with the tribes' water settlement and contract terms (Section 3.18.4.3). Under the

Proposed Action the total energy charges for CAP over the period of extended operations from 2020 to 2044 would be $3,501 million under the 3-Unit Operation and $3,625 under the 2-Unit Operation (**Table 3.18-40** and **Technical Supplement 3.18-A**).

Increases in the cost of CAP water and reductions in the availability of revenues for the Development Fund would affect the tribes' decisions regarding whether or not it would be economically viable to utilize their CAP water rights and contracted CAP water entitlements.

3.20.4.3.7 Cumulative Impacts

3.20.4.3.7.1 Navajo Generating Station

As noted above and in Section 3.7.3.2, Water Resources, recharge from Lake Powell would be anticipated to cause the N-Aquifer to rise for the next 50 to 100 years, when hydraulic equilibrium would be reached. These recharge effects, coupled with the Proposed Action, are the only past, present or reasonably foreseeable future activities that have or would affect NGS-related Navajo Nation water trust assets. No impacts to Navajo Nation water trust assets would be anticipated from Proposed Action operations at NGS; therefore, no cumulative impacts to these resources would be anticipated.

Construction and operation of NGS are the only past, present and reasonably foreseeable actions associated with Navajo Nation land trust assets at those sites. The Navajo Nation has been and is compensated for past and present use of Navajo Nation land for those facilities under the terms of the 1969 Lease. The NGS Lease Amendment No. 1, which would be approved by the Secretary of Interior, would allow for continued use of Navajo Nation lands for NGS under the Proposed Action. Under the terms of the amended lease (or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1), the Navajo Nation would receive substantially increased revenues for such use (Section 3.20.4.3). No negative impacts to Navajo Nation land trust assets would be anticipated from Proposed Action NGS operations, decommissioning, or reclamation and, as no other activities for these lands are anticipated, no negative cumulative impacts to these trust assets would occur. Conversely, continued use of Navajo Nation trust lands for NGS would generate substantially increased revenues to the Navajo Nation over the period of the lease amendment, which would result in substantial benefit to the Navajo Nation.

3.20.4.3.7.2 Proposed Kayenta Mine Complex

Section 3.7.3.3 describes past and current effects of the Kayenta and former Black Mesa Mine on Navajo and Hopi water resources. Future pumping for the proposed KMC and community water supply withdrawals would be the only reasonably foreseeable future water withdrawal activities anticipated for the proposed KMC.

Current water uses at the Kayenta mine include domestic supply and sanitation, equipment and coal-processing operations and maintenance, dust suppression (as required by federal regulations), and providing water to nearby tribal residents. The PWCC leases and approved Surface Mining Control and Reclamation Act permit specify monitoring and maintenance of the N-Aquifer wells (OSMRE 2011).

The Kayenta Mine currently withdraws groundwater from seven wells that penetrate through the D-Aquifer to the N-Aquifer. In the past, eight wells were used, but one (NAV5) that was not being used has been plugged to prevent downward movement of poorer quality water from the D-Aquifer to the N-Aquifer. As of September 2015, two wells (NAV4 and NAV7) were open to both the D- and N-Aquifers at the proposed KMC. Migration of D-Aquifer water to the N-Aquifer through the wellbores at these locations has the potential to impact N-Aquifer water quality. Under the Proposed Action, there would be no open D-Aquifer zones in PWCC pumping wells.

Maximum N-Aquifer withdrawals for the mine were 4,740 acre-feet in 1982. That use declined substantially after 2005 (to 1,200 acre-feet per year) with the end of coal slurry pipeline operations that supplied the Mojave Generating Station. The mean annual pumping for 2006 through 2012 was approximately 1,273 acre-feet. Recent pumping from the mine's wells has varied from approximately 1,200 to 1,600 acre-feet per year. On the lease areas, PWCC monitors water levels in the N-Aquifer supply wells and associated observation wells.

In addition to PWCC's groundwater withdrawals for the Kayenta and former Black Mesa mine, studies indicate pumping by 27 tribal centers from 2008 through 2012 in the study area resulted in between 2,500 and 3,100 acre-feet per year being withdrawn for community uses.

Future mine withdrawals would average approximately 1,200 acre-feet per year through 2044, decline to 500 acre-feet per year through 2047 and then continue at 100 acre-feet per year from 2048 through 2057 before ceasing altogether.

Future groundwater drawdown from Proposed Action mine-related pumping combined with projected community water supply withdrawals would create greater depths to water in N-Aquifer wells. Based on the modeling conducted for this EIS, total groundwater pumping at the affected communities in 2110 would be almost six hundred percent of the volume of pumping in those communities in 2011. The maximum-year percentage of increase in lift at affected communities attributable to Proposed Action-related mine pumping for the proposed KMC under the Proposed Action would range from zero to 3.7 percent, with a median value of 0.7 percent. Consequently, while substantial cumulative increases in N-Aquifer withdrawals would occur over the assessment period, only a small portion of the increase would be attributable to pumping at the proposed KMC. This would result in negligible to minor negative impacts to Navajo Nation and Hopi Tribe water trust assets. The Navajo Nation and Hopi Tribe would be compensated for proposed KMC N-Aquifer water withdrawals.

The water assessment also concluded that negligible cumulative effects on N-Aquifer water quality would result from combined community and project-related pumping under the Proposed Action. Impacts on water quantity and quality in the Wepo Aquifer, alluvial aquifers, and streamflows in regional watersheds also would be negligible. Water fees paid to the Navajo Nation and Hopi Tribe for use at the proposed KMC would be expected to increase dramatically under the Proposed Action, mitigating project-related contributions to cumulative effects. Consequently, proposed KMC contributions to cumulative impacts on Navajo Nation and Hopi Tribe water trust assets would be negligible to minor.

Past, present and reasonably foreseeable future activities affecting Navajo Nation and Hopi Tribe land trust assets within the proposed KMC primarily would be associated with mining. Past effects on Navajo and Hopi lands associated with Kayenta and former Black Mesa mining activities are described in Section 3.14.3.2. At the time of this assessment, most of the land disturbed for former Back Mesa Mine activities has been backfilled, graded, topsoil applied, and reseeded. Approximately 75 percent of land disturbed from previous Kayenta Mine activities has been backfilled and graded, and approximately 50 percent has had topsoil applied and has been reseeded. Future effects on land resources would be limited to those associated with reclamation of previously mined lands and with the Proposed Action. Mined land would be reclaimed pursuant to the approved reclamation plan and existing lease agreements. PWCC would restore the land with equal or greater forage productivity than pre-mining conditions (Section 3.14) or for other approved uses including wildlife habitat and cultural plants. After OSMRE and BIA determine that reclamation is satisfactory and following the release of bonds, control of the surface use would revert to the Navajo Nation and Hopi Tribe. Consequently, negligible to minor cumulative impacts to Navajo Nation and Hopi Tribe land trust assets would be anticipated under Proposed Action operations, decommissioning, and reclamation at the proposed KMC.

Past, present, and reasonably foreseeable future effects on Navajo Nation and Hopi Tribe mineral trust assets within the proposed KMC area are associated with mining under the terms of the respective leases. Given that there is a low probability that commercially extractable minerals other than coal are present in the vicinity of the proposed KMC, effects would be limited to the mining of the coal resource. The Navajo Nation and Hopi Tribe have been compensated through royalty payments for mining and sales of the coal, and future royalty payments under the Proposed Action would represent continued revenues to the Navajo Nation and Hopi Tribe. Consequently, no cumulative impacts to Indian Trust mineral assets would be anticipated.

Past effects of mining on hunting within the proposed KMC have been associated with closure of areas due to active mining and changes in the vegetation mix on reclaimed lands. Those areas reopen as reclamation is completed. Reasonably foreseeable future hunting effects within the proposed KMC on Navajo Nation and Hopi Tribe hunting trust assets would involve closure of active mining areas under the Proposed Action. This would result in minor impacts on Navajo Nation and Hopi Tribe hunting trust assets due in part to the change in vegetation types over the long term in reclaimed mining areas.

3.20.4.3.7.3 Transmission Systems and Communication Sites

Ongoing maintenance, repair, replacement, and improvement of the transmission lines, substations, and communication sites would be the only reasonably foreseeable future activities for those systems and sites. No construction, major replacement, or other activities would be anticipated. Consequently, no cumulative impacts to Kaibab Band of Paiute Indians or Moapa Band of Paiute Indians land trust assets associated with the transmission lines and communication sites would be anticipated.

3.20.4.3.7.4 Central Arizona Project

No reasonably foreseeable future actions would be anticipated that would affect the water rights held in trust by the federal government for the tribes that have received CAP water entitlements as a result of water settlements

Future shortages of Colorado River water could affect the availability of CAP water, although such shortages would not be likely to affect the priority schedules associated with the tribes' water settlements. Decreases in water deliveries would occur under a declared shortage on the Colorado River, such that fixed operation, maintenance, and reclamation costs would need to be recovered based on a lesser quantity of water deliveries (Section 3.18.4.3).

Preliminary assessment from the Central Arizona Water Conservation District indicates that pumping rates for water delivery could increase substantially, commensurate with the stage of water shortage (Section 3.18.4.3). These increases, coupled with Proposed Action increases in CAP water pumping costs and reductions in contributions to the Development Fund, would affect all CAP system customers. This would be particularly true for agricultural users, including CAP-affected tribes who use all or parts of their allocations for agricultural purposes. These cost increases could affect the tribes' decisions regarding whether or not it would be economically viable to utilize their CAP water rights and contracted CAP water entitlements. Cumulative increases in water rates also could result in higher levels of groundwater pumping. This could result in lower farm income, which could in turn result in farming operations being scaled back, changes in cropping patterns, or changes in the amount of land in production. Higher energy rates also could hamper CAP-affected tribes' plans to support future commercial and industrial development uses and population growth and their ability to reestablish traditional irrigation-based agriculture on their reservations.

3.20.4.4 Natural Gas Partial Federal Replacement Alternative

The Natural Gas PFR Alternative would involve replacement of 100 MW to 250 MW of power generation at NGS by alternative power purchased from existing but unknown natural gas generation sources. NGS would curtail its output by the corresponding amount, continuing operations to generate the remaining federal share, including excess energy available to market as surplus.

It is unknown whether the existing natural gas generation facility(ies) would be located on trust lands of a federally recognized Indian tribe. Consequently, prior and future impacts to Indian trust assets cannot not be evaluated for the Natural Gas PFR Alternative source facility. However, because it is assumed that the replacement power would be purchased from an existing facility, future impacts to Indian trust assets likely would be negligible if the facility were located on tribal trust lands because little if any additional land would be involved.

Under the Natural Gas PFR Alternative, NGS operations would continue through late 2044, and decommissioning activities would occur through 2045. Future NGS operations would include either 3-Unit Operation or 2-Unit Operation and essentially be consistent with historical operations with the exception that NGS would curtail its generation by an amount equivalent to energy purchased from a natural gas fired alternative. Future operations would include the use of coal supplied by the proposed KMC and transported by the BM&LP Railroad, use of water from Lake Powell for cooling, ash disposal both in the on-site disposal landfill and sold for off-site use and periodic overhauls.

3.20.4.4.1 Navajo Nation

3.20.4.4.1.1 Water

Under the Natural Gas PFR Alternative, the effects of NGS operations, decommissioning, and reclamation on groundwater would be the same as those associated with the Proposed Action. Consequently, no impacts on Navajo Nation water trust assets from NGS would be anticipated under the Natural Gas PFR Alternative.

Water use at the proposed KMC would be the same as under the Proposed Action for the Natural Gas PFR Alternative; therefore mine-related N-Aquifer impacts also would be the same. The increased fee rates for use of water from the N-Aquifer would substantially increase revenues over those that historically have been received by the Navajo Nation. Impacts to groundwater levels and quality in shallow aquifers on the leasehold would be the same or slightly less than the Proposed Action due to a reduction in new mining disturbance and the potential for corresponding changes in mine configurations. Consequently, negligible to moderate impacts on Navajo Nation water trust assets from KMC operations under the Natural Gas PFR Alternative would be anticipated.

3.20.4.4.1.2 Land

Land use effects at NGS resulting from implementation of Natural Gas PFR Alternatives would be the same as those associated with the Proposed Action. Land disturbed at NGS would be restored as closely as possible to original condition, as required by the 1969 Lease and Lease Amendment No. 1 (or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1. Total NGS-related payments to the Navajo Nation would be the same for the Natural Gas PFR Alternative as for the Proposed Action. The lease amendment has been negotiated between NGS and the Navajo Nation; if approved by the Secretary of the Interior, it would be considered consistent with the U.S. Department of the Interior’s trust responsibilities for Indian trust assets. No negative impacts to Navajo Nation land trust assets would be anticipated under the Natural Gas PRF Alternative, and the beneficial effects of higher NGS-related payments to the Navajo Nation would be substantial.

Land use impacts on the proposed KMC would be the same as the Proposed Action except that 5 to 18 percent less surface disturbance could occur because less coal would be mined. This could change the number of residents that would require relocation. Land mined at the proposed KMC would be reclaimed pursuant to the approved reclamation plan and existing lease agreements. The Navajo Nation would be compensated for use of its land through the payment of coal royalties as described in the following minerals subsection. The mitigation and compensation strategies that would be provided and the steps that would be taken as part of decommissioning and reclamation would result in negligible to minor impacts to Navajo Nation land trust assets would be anticipated.

3.20.4.4.1.3 Minerals

Annual coal requirements for the Natural Gas PFR would be between 0.4 million and 1.0 million tons lower than those under the Proposed Action. The differences associated with the 2-Unit Operation would be in addition to the 2.6 million tpy reduction associated with retirement of one unit under the 2-Unit Operation. The lower coal production would reduce future royalty and bonus payments to the Navajo Nation and Hopi Tribe, although the revenues would remain substantial. Over the period of extended operations from 2020 to 2044, royalty and bonus payments to the Navajo Nation and Hopi Tribe would total between $1.14 billion and $682 million. Approximately 67 percent of those revenues would accrue to the Navajo Nation. The compensation, existing lease agreements, permits, and ROWs were negotiated between PWCC and the Navajo Nation with BIA oversight; therefore, they would be consistent with the U.S. Department of the Interior's trust responsibilities for Indian trust assets. BLM also would monitor mining operations and review production reports and royalty and bonus payments to ensure compliance with lease provisions. Negative impacts to Navajo Nation mineral trust assets would be negligible, and beneficial effects of continued coal royalties for the Navajo Nation would be substantial.

3.20.4.4.1.4 Hunting

As with the Proposed Action, the Navajo Nation would maintain hunting rights on lands outside the leased area for NGS and outside active mining areas on the proposed KMC under the Natural Gas PFR Alternative. Fewer lands could be withdrawn from hunting access because 5 to 18 percent less coal would be mined than under the Proposed Action. Although active mining areas would be withdrawn from hunting, reclaimed mining areas would be available for these uses. In some cases the vegetation mix on reclaimed lands would be different than predisturbance conditions, resulting in negligible to minor impacts to Navajo Nation hunting trust assets.

3.20.4.4.2 Hopi Tribe

3.20.4.4.2.1 Water

Water use at the proposed KMC would be the same for the Natural Gas PFR Alternative as under the Proposed Action; therefore, mine-related N-Aquifer impacts would be the same as those from the Proposed Action. Impacts to groundwater levels and quality in shallow aquifers on the leasehold would be the same or slightly less than in the comparable Proposed Action operation due to reductions in new mining disturbance and the potential for corresponding changes in mine configurations. The Hopi Tribe would be compensated for use of N-Aquifer water, and the increased water fee rates would substantially increase revenues over those that historically have been received by the Hopi Tribe. Consequently, moderate to negligible negative impacts on Hopi Tribe water trust assets from KMC operations would be anticipated under the Natural Gas PFR Alternative, and the effects of higher water payments to the Hopi Tribe would be beneficial.

3.20.4.4.2.2 Land

Impacts on Hopi Tribe land trust assets at the proposed KMC would be the same as the Proposed Action except that 5 to 18 percent less surface disturbance could occur because less coal would be mined. Land mined at the proposed KMC would be reclaimed pursuant to the approved reclamation plan and existing lease agreements. The Hopi Tribe would be compensated for use of its land through the payment of coal royalties as described in the following minerals subsection. Because of the mitigation and compensation strategies that would be provided and the steps that would be taken as part of decommissioning and reclamation, negligible to minor impacts to Hopi tribal land trust assets would be anticipated.

3.20.4.4.2.3 Minerals

Annual coal requirements for the Natural Gas PFR Alternative would be between 0.4 million and 1.0 million tons lower than those under the Proposed Action. The differences associated with the 2-Unit

Operation would be in addition to the 2.6 million tpy reduction associated with retirement of one unit under the 2-Unit Operation. The lower coal production would reduce future royalty and bonus payments to the Navajo Nation and Hopi Tribe, although the revenues would remain substantial. Over the period of extended operations from 2020 to 2044, royalty and bonus payments to the Navajo Nation and Hopi Tribe would total between $1.14 billion and $682 million. Approximately 33 percent of those revenues would accrue to the Hopi Tribe. Compensation, existing lease agreements, permits, and ROWs were negotiated between PWCC and the Hopi Tribe with BIA oversight; therefore, they would be consistent with the U.S. Department of the Interior's trust responsibilities for Indian trust assets. BLM would monitor mining operations and review production reports and royalty and bonus payments to ensure compliance with lease provisions. Negative impacts to Hopi Tribe mineral trust assets would be negligible, and beneficial effects of continued coal royalties to the Hopi Tribe would be substantial.

3.20.4.4.2.4 Hunting

As with the Proposed Action, the Hopi Tribe would maintain hunting rights on its land outside active mining areas on the proposed KMC under the Natural Gas PFR Alternative. Fewer lands could be withdrawn from hunting access because 5 to 18 percent less coal would be mined than under the Proposed Action. Although active mining areas would be withdrawn from hunting, reclaimed mining areas would be available for these uses. In some cases the vegetation mix on reclaimed lands would be different than predisturbance conditions, resulting in negligible to minor impacts to Hopi Tribe hunting trust assets.

3.20.4.4.3 Kaibab Band of Paiute Indians

Effects of the Natural Gas PFR Alternative on Kaibab Band of Paiute Indians trust land assets would be the same as those described for the Proposed Action. There would be no change in either the WTS or communication site easement use or in ongoing operation, maintenance, and repair activities; consequently, there would be no impacts to Kaibab Band of Paiute Indians trust land assets.

3.20.4.4.4 Moapa Band of Paiute Indians

Effects of the Natural Gas PFR Alternative on Moapa Band of Paiute Indians trust land assets would be the same as those described for the Proposed Action. There would be no change in the easement's use or in ongoing operation, maintenance, and repair activities; consequently, there would be no impacts to Moapa Band of Paiute Indians trust land assets.

3.20.4.4.5 CAP-affected Tribes

As with the Proposed Action, implementation of the Natural Gas PFR Alternative would not affect water rights held by tribes who received CAP water through water settlements, which are held in trust by the federal government and are considered Indian trust assets.

Users of CAP water, including CAP-affected tribes, would experience indirect effects associated with differences in pumping costs related to energy costs under the Natural Gas PFR Alternative compared to those under the Proposed Action (Section 3.18.4.4). Under the Natural Gas PFR Alternative, the CAP's total energy charges over the period of extended operations between 2020 and 2044 would be between $3,381 million and $4,275 million under a 3-Unit Operation and between $3,356 million and $4,246 million under a 2-Unit Operation (**Table 3.18-50** and **Technical Supplement 3.18-A**). Those costs represent between 3 percent lower and 22 percent higher (3-Unit Operation) and between 7 percent lower and 17 percent higher (2-Unit Operation) compared to those under the Proposed Action.

The potential differences in pumping costs for CAP water users under the Natural Gas PFR Alternative would result in indirect effects to all CAP users. Energy costs associated with the Natural Gas PFR Alternative could affect the economic feasibility of surplus energy sales, both in terms of the likelihood and value of such energy sales.

Continued low natural gas prices could offer lower rates and result in savings to CAP and its customers including CAP-affected tribes. On the other hand, higher natural gas prices would raise energy costs, further undermining the likelihood for surplus energy sales and surplus revenues to the Development Fund. Conceivably, the loss of surplus revenue sales and impacts of curtailment costs associated with higher levels of replacement energy could raise costs to the point that would render the energy economically unjustifiable for the CAP.

3.20.4.4.6 Project Impact Summary – All Project Components

Navajo Nation and Hopi Tribe Indian trust assets that potentially would be affected by NGS under the Natural Gas PFR Alternative include land and water. The effects on these Indian trust assets resulting from implementation of the Natural Gas PFR Alternative would be substantially the same as those associated with the Proposed Action under the respective 3-Unit Operation and 2-Unit Operation. No negative impacts on Navajo Nation water or land trust assets would be anticipated for NGS from implementation of the Natural Gas PFR Alternative, and the beneficial effects of higher NGS-related payments to the Navajo Nation would be substantial.

Navajo Nation and Hopi Tribe Indian trust assets that would be affected by operations of the proposed KMC include water, land, minerals, and hunting. Annual coal requirements for the Natural Gas PFR Alternative would be between 0.4 million and 1.0 million tpy lower than those for the Proposed Action. Approximately 5 to 18 percent less surface disturbance could occur within the proposed KMC because less coal would be mined. The lower coal production would reduce future lease, royalty, bonus, and water payments to the Navajo Nation and Hopi Tribe, although the revenues would remain substantial.

Water use and groundwater pumping effects at the proposed KMC essentially would be the same as those associated with the Proposed Action, with the exception that impacts to groundwater levels and quality in shallow aquifers on the leasehold would be the same or slightly less than in the Proposed Action due to a reduction in new disturbance and potential changes in mine configurations. Consequently, negligible to moderate impacts would be anticipated on Navajo Nation and Hopi Tribe water trust assets from KMC operations under the Natural Gas PFR Alternative.

Effects on Navajo Nation and Hopi Tribe land trust assets essentially would be the same as under the Proposed Action with the exception that less surface disturbance could occur. This could change the number of residents that would require relocation and the amount of grazing land withdrawn. The mitigation and compensation strategies that would be provided and the steps taken as part of decommissioning and reclamation would result in negligible to minor impacts to Navajo Nation and Hopi Tribe land trust assets under the Natural Gas PFR Alternative.

Annual coal requirements for the Natural Gas PFR Alternative would be between 0.4 million and 1.0 million tons lower than those for the Proposed Action. Over the period of extended operations from 2020 to 2044, royalty, bonus, and water payments to the Navajo Nation and Hopi Tribe would total between $1.14 billion and $682 million. Negative impacts to Navajo Nation and Hopi Tribe mineral trust assets would be negligible under the Natural Gas PFR Alternative and beneficial effects of continued coal royalties to the Hopi Tribe would be substantial.

Effects on Navajo Nation and Hopi Tribe hunting trust assets would be similar to those associated with the Proposed Action. As with the Proposed Action, the vegetation mix on reclaimed lands would be different than predisturbance conditions in some cases, which would result in negligible to minor impacts to Navajo Nation and Hopi Tribe hunting trust assets under the Natural Gas PFR Alternative.

Effects on Kaibab Band of Paiute Indians and Moapa Band of Paiute Indians trust land assets associated with the WTS transmission system and communication site would be limited to ongoing use of the land, for which the respective tribes are compensated by lease agreements. There would be no change in either the WTS or communication site easement use or in ongoing operation, maintenance and repair activities; consequently, impacts to Indian trust assets would be negligible.

Implementation of the Natural Gas PFR Alternative would not affect water rights held by tribes who received CAP water through water settlements that are held in trust by the federal government and are considered Indian trust assets.

Users of CAP water including CAP-affected tribes, would experience indirect effects associated with the range of somewhat lower to substantially higher pumping costs related to energy costs under the Natural Gas PFR Alternative compared to those under the Proposed Action. Continued low natural gas prices could offer lower rates and result in savings to CAP. Higher natural gas prices would raise energy costs, further undermining the likelihood for surplus energy sales and surplus revenues to the Development Fund. Conceivably, the loss of surplus revenue sales and impacts of curtailment costs associated with higher levels of replacement energy could raise costs to the point that would render this alternative's energy economically unjustifiable for CAP. To the degree that increases in the cost of generating NGS power would reduce the marketability of surplus NGS power, revenues to the Development Fund could decrease. Increases in the cost of CAP water and reductions in the availability of revenues for the Development Fund could affect the Tribes' decisions regarding whether or not it would be economically viable to utilize their CAP water rights and contracted CAP water entitlements.

3.20.4.4.7 Cumulative Impacts

3.20.4.4.7.1 Navajo Generating Station

Cumulative effects on Navajo Nation water and land trust assets resulting from operations, decommissioning, and reclamation of NGS and past, present, or reasonably foreseeable future activities under the Natural Gas PFR Alternative would be the same as those associated with the Proposed Action.

3.20.4.4.7.2 Proposed Kayenta Mine Complex

Cumulative effects on Navajo Nation and Hopi Tribe water, land, and mineral trust assets resulting from implementation of the Natural Gas PFR Alternative related to the proposed KMC would be similar to those associated with the Proposed Action. Minor differences would be associated with the lesser amounts of coal mined at KMC due to the replacement of power generation at NGS under the Natural Gas PFR Alternative. Impacts to groundwater levels and quality in shallow aquifers on the leasehold would be the same or slightly less than under the Proposed Action due to a reduction in new mining disturbance and the potential for corresponding changes in mine configurations. Cumulative land use effects would be the same as the Proposed Action, except that 5 to 18 percent less coal would be mined potentially reducing the amount of surface disturbance that would occur on the proposed KMC. This could result in fewer resident relocations and fewer grazing lands withdrawn for mining. Fewer Navajo Nation and Hopi Tribe lands vould be withdrawn from hunting access under the Natural Gas PFR Alternative because less coal would be mined. Over the period of extended operations from 2020 to 2044, royalty and bonus payments to the Navajo Nation and Hopi Tribe would be lower under the Natural Gas PFR Alternative than under the Proposed Action; however, they would remain substantial and account for large portions of the budgets of both the Navajo Nation and the Hopi Tribe.

3.20.4.4.7.3 Transmission Systems and Communication Sites

Cumulative effects on Kaibab Band of Paiute Indians or Moapa Band of Paiute Indians land trust assets would be the same under the Natural Gas PFR Alternative as under the Proposed Action, and no impacts to these Indian trust assets would be anticipated.

3.20.4.4.7.4 Central Arizona Project

Cumulative effects on water rights of tribes that have received CAP water entitlements would be the same for the Natural Gas PFR Alternative as under the Proposed Action. Cumulative effects of CAP pumping costs and reductions in contributions to the Development Fund associated with Colorado River water shortages could be greater or lesser than those associated with the Proposed Action, depending on natural gas prices at the time shortages were to occur.

3.20.4.5 Renewable Partial Federal Replacement Alternative

The following summarizes the impacts to Indian trust assets if a selected quantity of firm power between 100 MW and 250 MW would be contracted for delivery under a long-term power purchase agreement from existing renewable generation sources, with energy supplied to the CAP during a defined time period (e.g., 14 hours per day). The net result would be replacement power providing the equivalent of between 58.3 MW hours and 145.8 MW hours over the course of a typical 24-hour period. Implementation of the Renewable PFR Alternative assumes NGS output would be curtailed to lower the federal share of NGS energy by an amount corresponding to the amount of energy purchased. Generation from two or more sources, possibly involving different technologies, would be required to supply the necessary level of power for the defined duration. For this assessment, it is assumed that the source(s) would already exist, rather than a new project built specifically to meet Central Arizona Water Conservation District demand. The location of the facility or facilities that would provide the renewable energy is not know, nor is it known if the facility would be located on trust land of a federally recognized Indian tribe. Therefore, prior and future impacts to Indian trust assets were not evaluated. However, because the replacement power would be purchased from an existing facility, future impacts to Indian trust assets likely would be negligible if the facility were located on tribal trust lands.

3.20.4.5.1 Navajo Nation

3.20.4.5.1.1 Water

Under the Renewable PFR Alternative, the effects of NGS operations on groundwater would be the same as those associated with the Proposed Action. Implementation of the NGS Groundwater Protection Plan, Perched Water Dewatering Plan, the Phase I and II Environmental Site Assessments (and remediation as required), and compliance with USEPA’s Coal Combustion Residuals rule would be protective of groundwater at NGS during operations, decommissioning, and reclamation. Consequently, no impacts on Navajo Nation water trust assets from NGS operations under the Renewable PFR Alternative would be anticipated.

Water use at the proposed KMC would be the same as under the Proposed Action for the Renewable PFR Alternative; therefore, mine-related N-Aquifer impacts at the proposed KMC would be the same as those from the Proposed Action. Impacts to groundwater levels and quality in shallow aquifers on the leasehold would be the same or slightly less than in a comparable Proposed Action due to a reduction in new mining disturbance and the potential for corresponding changes in mine configurations. Consequently, negligible to moderate impacts on Navajo Nation water trust assets from KMC operations under the Renewable PFR Alternative would be anticipated. The Navajo Nation would be compensated for use of Navajo Nation water, and the increased fee rates for use of water from the N-Aquifer would substantially increase revenues over those that have been historically have been received by the Navajo Nation. Consequently, no impacts on Navajo Nation water trust assets from proposed KMC operations under the Renewable PFR Alternative would be anticipated.

3.20.4.5.1.2 Land

Land use effects on NGS resulting from implementation of Renewable PFR Alternative would be the same as those associated with the Proposed Action. Land disturbed at NGS would be restored as closely as possible to original condition where the surface of any leased land has been modified or improved, as required by the 1969 Lease and Lease Amendment No. 1 (or a leasing agreement with the

Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1. Total NGS-related payments to the Navajo Nation would be the same for the Renewable PFR Alternative as for the Proposed Action. No negative impacts to Navajo Nation land trust assets would be anticipated under the Renewable PRF Alternative and the beneficial effects of higher NGS-related payments to the Navajo Nation would be substantial.

Land use impacts on the proposed KMC would be the same as the Proposed Action except that 3 to 10 percent less surface disturbance could occur because less coal would be mined. This could change the number of residents that would require relocation. Land mined at the proposed KMC would be reclaimed pursuant to the approved reclamation plan and existing lease agreements. The Navajo Nation would be compensated for use of its land through the payment of coal royalties as described in the following minerals subsection. Mitigation and compensation strategies that would be provided and the steps that would be taken as part of decommissioning and reclamation would result in negligible to minor impacts to Navajo Nation land trust assets would be anticipated.

3.20.4.5.1.3 Minerals

Annual coal requirements for the Renewable PFR Alternative would be between 0.2 million and 0.6 million tpy lower than those under the Proposed Action. The differences would be in addition to the 2.6 million tpy reduction associated with retirement of one unit under the 2-Unit Operation The lower coal production would reduce future royalty and bonus payments to the Navajo Nation and Hopi Tribe, although the revenues would remain substantial. Over the period of extended operations from 2020 to 2044, royalty and bonus payments to the Navajo Nation and Hopi Tribe would total between $1.16 billion and $739 million. Approximately 67 percent of those revenues would accrue to the Navajo Nation. The compensation, existing lease agreements, permits, and ROWs were negotiated between PWCC and the Navajo Nation with BIA oversight; therefore, they would be consistent with the U.S. Department of the Interior's trust responsibilities for Indian trust assets. BLM also would monitor mining operations and review production reports and payments and royalty payments to ensure compliance with lease provisions. Negative impacts to Navajo Nation mineral trust assets would be negligible, and beneficial effects of continued coal royalties for the Navajo Nation would be substantial.

3.20.4.5.1.4 Hunting

As with the Proposed Action, the Navajo Nation would have rights to continue hunting on lands outside the leased area for NGS, and outside active mining areas on the proposed KMC under the Renewable PFR Alternative. Fewer lands could be withdrawn from hunting access because 3 to 10 percent less coal would be mined under the Proposed Action. Although active mining areas would be withdrawn from hunting, reclaimed mining areas would be available for these uses. In some cases, the vegetation mix on reclaimed lands would be different than predisturbance conditions, resulting in negligible to minor impacts to Navajo Nation hunting trust assets.

3.20.4.5.2 Hopi Tribe

3.20.4.5.2.1 Water

Water use at the proposed KMC would be the same as under the Proposed Action for the Renewable PFR Alternative; therefore, mine-related N-Aquifer impacts at the proposed KMC also would be the same. Impacts to groundwater levels and quality in shallow aquifers on the leasehold would be the same or slightly less than the Proposed Action, due to reductions in new mining disturbance and the potential for corresponding changes in mine configurations. The Hopi Tribe would be compensated for use of N-Aquifer water, and the increased water fee rates would increase revenues substantially over those that historically have been received by the Hopi Tribe. Consequently, moderate to negligible negative impacts on Hopi Tribe water trust assets from the proposed KMC would be anticipated under the Renewable PFR Alternative, and the effects of higher water payments to the Hopi Tribe would be beneficial.

3.20.4.5.2.2 Land

Impacts on Hopi land trust assets at the proposed KMC would be the same as the Proposed Action except that 3 to 10 percent less surface disturbance could occur because less coal would be mined. Land mined at the proposed KMC would be reclaimed pursuant to the approved reclamation plan and existing lease agreements. The Hopi Tribe would be compensated for use of its land through the payment of coal royalties as described in the following minerals subsection. Because of the mitigation and compensation strategies that would be provided and the steps that would be taken as part of decommissioning and reclamation, negligible to minor impacts to Navajo Nation land trust assets would be anticipated.

3.20.4.5.2.3 Minerals

Annual coal requirements for the Renewable PFR Alternative would be between 0.2 million and 0.6 million tpy lower than those with the Proposed Action. The differences would be in addition to the 2.6 million tpy reduction associated with retirement of one unit under the 2-Unit Operation. The lower coal production would reduce future royalty and bonus payments to the Navajo Nation and Hopi Tribe, although the revenues would remain substantial. Over the period of extended operations from 2020 to 2044, royalty and bonus payments to the Navajo Nation and Hopi Tribe would total between $1.16 billion and $739 million. Approximately 33 percent of those revenues would accrue to the Hopi Tribe. Compensation, existing lease agreements, permits, and ROWs were negotiated between PWCC and the Hopi Tribe with BIA oversight; therefore, they would be consistent with the U.S. Department of the Interior's trust responsibilities for Indian trust assets. BLM also would monitor mining operations and review production reports and payments and royalty payments to ensure compliance with lease provisions. Negative impacts to Hopi Tribe mineral trust assets would be negligible, and beneficial effects of continued coal royalties to the Hopi Tribe would be substantial.

3.20.4.5.2.4 Hunting

As with the Proposed Action, the Hopi Tribe would have rights to continue hunting on its lands outside active mining areas on the proposed KMC under the Renewable PFR Alternative. Fewer lands could be withdrawn from hunting access under the Renewable PFR Alternative because 3 to 10 percent less coal would be mined than under the Proposed Action. Although active mining areas would be withdrawn from hunting, reclaimed mining areas would be available for these uses. In some cases the vegetation mix on reclaimed lands would be different than predisturbance conditions, resulting in negligible to minor impacts to Hopi Tribe hunting trust assets.

3.20.4.5.3 Kaibab Band of Paiute Indians

Effects of the Renewable PFR Alternative on Kaibab Band of Paiute Indians trust land assets would be the same as those described for the Proposed Action. There would be no change in either the WTS or communication site easement use or in ongoing operation, maintenance and repair activities. Consequently, there would be no impacts to Kaibab Band of Paiute Indians land trust assets.

3.20.4.5.4 Moapa Band of Paiute Indians

Effects of the Renewable PFR Alternative on Moapa Band of Paiute Indians land trust assets would be the same as those described for the Proposed Action. There would be no change in the easement's use or in ongoing operation, maintenance, and repair activities. Consequently, there would be no impacts to Moapa Band of Paiute Indians trust land assets.

3.20.4.5.5 CAP-affected Tribes

As with the Proposed Action, implementation of the Renewable PFR Alternative would not affect water rights held by tribes who received CAP water through water settlements, which are held in trust by the federal government and are considered Indian trust assets.

Pumping energy costs for the CAP would increase under the Renewable PFR Alternative, with energy costs potentially much higher with 250 MW of replacement energy. Total pumping energy costs over the 2020 to 2044 time period would be between $3,779 million and $4,126 million under a 3-Unit Operation and between $3,875 million and $4,199 million under a 2-Unit Operation (**Table 3.18-60** and **Technical Supplement 3.18-A**). Those costs represent increases of 8 and 18 percent (3-Unit Operation) and between 7 and 16 percent (2-Unit Operation) compared to those under the Proposed Action.

The unavoidable costs associated with SCR installation, Lease Amendment No. 1, and basic operating costs would account for a portion of the increase, but costs associated with curtailment and firming would account for the majority of the increases, particularly as the amount of energy provided by the Renewable PFR rises.

The effects of the differences would be most pronounced for entities that use CAP-delivered water for agricultural purposes (including the agricultural uses of CAP-affected tribes) as pumping costs are essentially all or the majority of their costs. The higher energy costs under this alternative could negatively affect the economic feasibility of future sales of surplus energy yielding revenues to support to the Development Fund, making it economically unjustifiable to purchase energy and power from NGS to operate the CAP.

3.20.4.5.6 Project Impact Summary – All Project Components

Navajo Nation trust assets potentially affected by NGS under the Renewable PFR Alternative include land and water. The effects on these Indian trust assets resulting from implementation of the Renewable PFR Alternative essentially would be the same as those associated with the Proposed Action. No negative impacts on Navajo Nation water or land trust assets would be anticipated for NGS from implementation of the Renewable PFR Alternative, and the beneficial effects of higher NGS-related payments to the Navajo Nation would be substantial.

Navajo Nation and Hopi Tribe trust assets affected by operations of the proposed KMC include water, land, minerals, and hunting. Annual coal requirements for the Renewable PFR Alaternative would be between 0.2 million and 0.6 million tons lower than those for the Proposed Action. The difference would be in addition to the 2.6 million tpy reduction associated with retirement of one unit with the 2-Unit Operation. Approximately 3 to 10 percent less surface disturbance could occur within the proposed KMC because less coal would be mined than under the Proposed Action. The lower coal production would reduce future royalty and bonus payments to the Navajo Nation and Hopi Tribe, although the revenues would remain substantial.

Water use and groundwater pumping effects at the proposed KMC essentially would be the same as those associated with the Proposed Action, with the exception that impacts to groundwater levels and quality in shallow aquifers on the leasehold would be the same or slightly less than in a Proposed Action due to a reduction in new mining disturbance and the potential for corresponding changes in mine configurations. Consequently, negligible to moderate impacts would be anticipated on Navajo Nation and Hopi Tribe water trust assets from KMC operations under the Renewable PFR Alternative.

Effects on Navajo and Hopi land trust assets essentially would be essentially the same as under the Proposed Action with the exception that approximately 5 to 18 percent less surface disturbance could occur because less coal would be mined. This could change the number of residents that would require relocation and the amount of grazing land that would be withdrawn. The mitigation and compensation strategies that would be provided and the steps that would be taken as part of decommissioning and reclamation would result in negligible to minor impacts to Navajo Nation and Hopi Tribe land trust assets under the Renewable PFR Alternative.

As noted above, annual coal requirements for the Renewable PFR Alternative would be between 0.2 million and 0.6 million tons lower than those with the Proposed Action. Over the period of extended operations from 2020 to 2044, royalty and bonus payments to the Navajo Nation and Hopi Tribe would total between $1.16 billion and $739 million. Negative impacts to Navajo Nation and Hopi Tribe mineral trust assets would be negligible under the Renewable PFR Alternative, and beneficial effects of continued coal royalties to the Hopi Tribe would be substantial.

Effects on Navajo Nation and Hopi Tribe hunting trust assets would be similar to those associated with the Proposed Action, except approximately 3 to 10 percent fewer hunting lands could be withdrawn during active mining. As with the Proposed Action, the vegetation mix on reclaimed lands would be different than predisturbance conditions in some cases, resulting in negligible to minor impacts to Navajo Nation and Hopi Tribe hunting trust assets under the Renewable PFR Alternative.

Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

Effects on Kaibab Band of Paiute Indians and Moapa Band of Paiute Indians trust land assets associated with the WTS transmission system and communication site would be limited to ongoing use of the land, for which the respective tribes are compensated by lease agreements. There would be no change in either the WTS or communication site easement use or in ongoing operation, maintenance and repair activities. Consequently, impacts to Indian trust assets would be negligible.

As with the Proposed Action, implementation of the Renewable PFR Alternative would not affect water rights held by tribes who received CAP water through water settlements, which are held in trust by the federal government, and are considered Indian trust assets. However, users of CAP water, including CAP-affected tribes, would experience indirect effects associated with substantially higher pumping costs related to energy costs under the Renewable PFR Alternative compared to those under the Proposed Action. Continued low renewable energy prices could offer lower rates and result in savings to CAP. On the other hand, higher renewable energy prices would raise this alternative's energy costs, further undermining the likelihood for surplus energy sales and surplus revenues. Conceivably, the loss of surplus revenue sales and impacts of curtailment costs associated with higher levels of replacement energy could raise costs to the point that would render the energy economically unjustifiable for CAP. To the degree that increases in the cost of generating NGS power would reduce the marketability of surplus NGS power, revenues to the Development Fund could decrease. Increases in the cost of CAP water and reductions in the availability of revenues to the Development Fund could affect the tribes' decisions regarding whether or not it would be economically viable to utilize their CAP water rights and contracted CAP water entitlements.

3.20.4.5.7 Cumulative Impacts

3.20.4.5.7.1 Navajo Generating Station

Cumulative effects on Navajo Nation water and land trust assets resulting from operations, decommissioning, and reclamation of NGS and past, present, or reasonably foreseeable future activities under the Renewable PFR Alternative would be the same as those associated with the Proposed Action.

3.20.4.5.7.2 Proposed Kayenta Mine Complex

Cumulative effects on Navajo Nation and Hopi Tribe water, land, and mineral trust assets resulting from implementation of the Renewable PFR Alternative for the proposed KMC would be similar to those associated with the Proposed Action. Minor differences would be associated with the lesser amounts of coal mined at the proposed KMC due to replacement of the equivalent of between 58.3 MW hours and 145.8 MW hours over the course of a typical 24-hour period. Impacts to groundwater levels and quality in shallow aquifers on the leasehold would be the same or slightly less than the Proposed Action, due to a reduction in new mining disturbance and the potential for corresponding changes in mine configurations. Land use impacts on the proposed KMC would be the same as the Proposed Action except that 3 to

10 percent less surface disturbance could occur because less coal would be mined. This could result in fewer resident relocations and fewer grazing lands withdrawn for mining. Fewer Navajo Nation and Hopi Tribe trust lands would be withdrawn from hunting access under the Renewable PFR Alternative because a lesser amount of surface disturbance could occur. Over the period of extended operations from 2020 to 2044, royalty, bonus, and water payments to the Navajo Nation and Hopi Tribe would be lower under the Renewable PFR Alternative than under the Proposed Action but would remain substantial and account for large portions of the budgets of both the Navajo Nation and the Hopi Tribe.

3.20.4.5.7.3 Transmission Systems and Communication Sites

Cumulative effects on Kaibab Band of Paiute Indians or Moapa Band of Paiute Indians trust land assets would be the same under the Renewable PFR Alternative as under the Proposed Action.

3.20.4.5.7.4 Central Arizona Project

Cumulative effects on water rights of tribes that have received CAP water entitlements would be the same for the Renewable PFR Alternative as under the Proposed Action. Cumulative effects of CAP pumping costs and reductions in contributions to the Development Fund associated with Colorado River water shortages would be greater than those associated with the Proposed Action.

3.20.4.6 Tribal Partial Federal Replacement Alternative

Under the Tribal PFR Alternative, power and energy would be obtained through a power purchase agreement(s) from renewable sources (assumed to be photovoltaic solar facility[ies] located on the lands of the Navajo Nation, Hopi Tribe, or one or more tribes with CAP water allocations). Energy from the solar facility(ies) would be dedicated to meet a portion of CAP demands during daylight hours (e.g., 12 hours a day). The net result would be between 0.33 terrawatt hours and 0.84 terrawatt hours of energy would be sourced from the tribal facility annually, with the replacement solar power providing an average of between 38 MW hours and 94.9 MW hours per hour over a typical 24-hour period. It is assumed that between 1,200 and 3,000 acres would be required for construction and operations of the photovoltaic solar facility, but no lands have been designated for the construction of the facility. Water, land, and hunting most likely would be affected during construction and operations of a facility on tribal lands. Under the assumptions used for this analysis, lease payments to a host tribe could range between $1.4 and $3.5 million, depending on the size of the facility (**Table 3.18-65**). Indian trust assets associated with the affected tribal lands would be subject to U.S. trust responsibilities, and the effects on those Indian trust assets would be assessed in a subsequent NEPA document.

3.20.4.6.1 Navajo Nation

3.20.4.6.1.1 Water

Under the Tribal PFR Alternative, the effects of NGS operations on groundwater would be the same as those associated with the Proposed Action. Implementation of the NGS Groundwater Protection Plan, Perched Water Dewatering Plan, the Phase I and II Environmental Site Assessments (and remediation as required), and compliance with USEPA's Coal Combustion Residuals rule would be protective of groundwater at NGS during operations, decommissioning, and reclamation. Consequently, no impacts on Navajo Nation water trust assets from NGS operations under the Tribal PFR Alternative would be anticipated.

Water use at the proposed KMC would be the same as under the Proposed Action for the Tribal PFR Alternative; therefore, mine-related N-Aquifer impacts at the proposed KMC would be the same as those from the Proposed Action. Impacts to groundwater levels and quality in shallow aquifers on the leasehold would be the same or slightly less than for the Proposed Action due to a reduction in new mining disturbance and the potential for corresponding changes in mine configurations. Consequently, negligible to moderate impacts on Navajo Nation water trust assets from proposed KMC operations under the Tribal PFR Alternative would be anticipated. The Navajo Nation would be compensated for use of Navajo Nation water, and the increased fee rates for use of water from the N-Aquifer would substantially increase revenues over those that historically have been received by the Navajo Nation. No impacts on Navajo Nation trust water assets from proposed KMC operations under the Tribal PFR Alternative would be anticipated.

3.20.4.6.1.2 Land

Land use effects on NGS resulting from implementation of Tribal PFR Alternative would be the same as those associated with the Proposed Action. Land disturbed at NGS would be restored as closely as possible to original condition where the surface of any leased land has been modified or improved, as required by the 1969 Lease and Lease Amendment No. 1 (or a leasing agreement with the Navajo Nation having similar terms as the 1969 Lease and Lease Amendment No. 1. Total NGS-related payments to the Navajo Nation would be the same for the Tribal PFR Alternative as for the Proposed Action: $1.07 billion and $792.5 billion. The lease amendment was negotiated between NGS and the Navajo Nation. If approved by the Secretary of the Interior, it would be consistent with the U.S. Department of the Interior's trust responsibilities for Indian trust assets. No negative impacts to Navajo Nation land trust assets would be anticipated under the Tribal PRF Alternative, and the beneficial effects of higher NGS-related payments to the Navajo Nation would be substantial.

Land use impacts on the proposed KMC would be the same as the Proposed Action except that 2 to 7 percent less surface disturbance could occur because less coal would be mined. This could change the number of residents that would require relocation and reduce the amount of grazing land that would be withdrawn during active mining. Land mined at the proposed KMC would be reclaimed pursuant to the approved reclamation plan and existing lease agreements. The Navajo Nation would be compensated for use of its land through the payment of coal royalties as described in the following minerals subsection. The mitigation and compensation strategies that would be provided, and the steps that would be taken as part of decommissioning and reclamation would result in negligible to minor impacts to Navajo land trust assets would be anticipated.

3.20.4.6.1.3 Minerals

Annual coal requirements for the Tribal PFR Alternative would be between 0.2 million and 0.4 million tons lower than those for the Proposed Action. The differences would be in addition to the 2.6 million tpy reduction associated with retirement of one unit with the 2-Unit Operation. The lower coal production would reduce future royalty and bonus payments to the Navajo Nation and Hopi Tribe, although the revenues would remain substantial. Over the period of extended operations from 2020 to 2044, royalty and bonus payments to the Navajo Nation and Hopi Tribe would total between $1.169 billion and $763 million. Approximately 67 percent of those revenues would accrue to the Navajo Nation. The compensation, existing lease agreements, permits, and ROWs were negotiated between PWCC and the Navajo Nation with BIA oversight, therefore, they would be considered consistent with Interior's trust responsibilities for Indian trust assets. BLM would monitor mining operations and review production, royalty, and bonus payments to ensure compliance with lease provisions. Negative impacts to Navajo Nation mineral trust assets would be negligible, and beneficial effects of continued coal royalties for the Navajo Nation would be substantial.

3.20.4.6.1.4 Hunting

As with the Proposed Action, the Navajo Nation would have rights to continue hunting, grazing, and traditional uses of its lands outside the leased area for NGS and outside active mining areas on the proposed KMC under the Tribal PFR Alternative. Fewer lands could be withdrawn from hunting access because 2 to 7 percent less coal would be mined than under the Proposed Action. Although active mining areas would be withdrawn from hunting, reclaimed mining areas would be available for these uses. The vegetation mix on reclaimed lands would be different than predisturbance conditions in some cases, resulting in negligible to minor impacts to Navajo Nation hunting trust assets.

3.20.4.6.2 Hopi Tribe

3.20.4.6.2.1 Water

Water use at the proposed KMC under the Tribal PFR Alternative would be the same as under the Proposed Action; therefore, mine-related N-Aquifer impacts at the proposed KMC would be the same as those from the Proposed Action. Impacts to groundwater levels and quality in shallow aquifers on the leasehold would be the same or slightly less than under the Proposed Action due to reductions in new mining disturbance and the potential for corresponding changes in mine configurations. The Hopi Tribe would be compensated for use of N-Aquifer water, and the increased water fee rates would substantially increase revenues over those that historically have been received by the Hopi Tribe. Consequently, moderate to negligible negative impacts on Hopi Tribe water trust assets from proposed KMC operations would be anticipated under the Tribal PFR Alternative, and the effects of higher water payments to the Hopi Tribe would be beneficial.

3.20.4.6.2.2 Land

Impacts on Hopi land trust assets at the proposed KMC would be the same as the Proposed Action except that 2 to 7 percent less surface disturbance could occur because less coal would be mined. Land mined at the proposed KMC would be reclaimed pursuant to the approved reclamation plan and existing lease agreements. The Hopi Tribe would be compensated for use of its land through the payment of coal royalties as described in the following minerals subsection. The mitigation and compensation strategies that would be provided and the steps that would be taken as part of decommissioning and reclamation would result in negligible to minor impacts to Navajo Nation land trust assets.

3.20.4.6.2.3 Minerals

Annual coal requirements for the Tribal PFR Alternative would be between 0.2 million and 0.4 million tons lower than those under the Proposed Action. The differences would be in addition to the 2.6 million tpy reduction associated with retirement of one unit with the 2-Unit Operation. The lower coal production would reduce future royalty and bonus payments to the Navajo Nation and Hopi Tribe, although the revenues would remain substantial. Over the period of extended operations from 2020 to 2044, royalty and bonus payments to the Navajo Nation and Hopi Tribe would total between $1.169 billion and $763 million. Approximately 33 percent of those revenues would accrue to the Hopi Tribe. Compensation, existing lease agreements, permits, and ROWs were negotiated between PWCC and the Hopi Tribe with BIA oversight; therefore, they would be consistent with the U.S. Department of the Interior's trust responsibilities for Indian trust assets. BLM also would monitor mining operations and review production reports and payments and royalty payments to ensure compliance with lease provisions. Negative impacts to Hopi Tribe mineral trust assets would be negligible, and beneficial effects of continued coal royalties to the Hopi Tribe would be substantial.

3.20.4.6.2.4 Hunting

As with the Proposed Action, the Hopi Tribe would have rights to continue hunting on its lands outside active mining areas on the proposed KMC under the Tribal PFR Alternative. Fewer lands could be withdrawn from hunting access under the Tribal PFR Alternative because 2 to 7 percent less coal would be mined than under the Proposed Action. Although active mining areas would be withdrawn from hunting, reclaimed mining areas would be available for these uses. The vegetation mix on reclaimed lands would be different than predisturbance conditions in some cases, resulting in negligible to minor impacts to Hopi Tribe hunting trust assets.

3.20.4.6.3 Kaibab Band of Paiute Indians

Effects of the Tribal PFR Alternative on Kaibab Band of Paiute Indians trust land assets would be the same as those described for the Proposed Action. Operation of the WTS and STS would continue for the life of the project. The timing of decommissioning and final reclamation requirements for the WTS and STS ROWs ultimately would be determined by the authorities with responsibility for ROW issuance.

There would be no change in either the WTS or communication site easement use or in ongoing operation, maintenance and repair activities. Consequently, there would be no impacts to Kaibab Band of Paiute Indians trust land assets.

3.20.4.6.4 Moapa Band of Paiute Indians

Effects of the Tribal PFR Alternative on Moapa Band of Paiute Indians trust land assets would be the same as those described for the Proposed Action. There would be no change in the easement's use or in ongoing operation, maintenance and repair activitiesl. Consequently, there would be no impacts to Moapa Band of Paiute Indians trust land assets.

3.20.4.6.5 CAP-affected Tribes

As with the Proposed Action, implementation of the Tribal PFR Alternative would not affect water rights held by tribes who received CAP water through water settlements, which are held in trust by the federal government and are considered Indian trust assets.

Pumping energy costs for the CAP would increase under the Tribal PFR operation, with energy costs potentially much higher with 250 MW of replacement energy. Total pumping energy costs over the 2020 to 2044 time period would be between $3,678 million and $3,922 million under a 3-Unit Operation and between $3,790 million and $3,998 million under a 2-Unit Operation (**Table 3.18-71** and **Technical Supplement 3.18-A**). Those costs represent increases of 5 and 12 percent (3-Unit Operation) and between 5 and 10 percent (2-Unit Operation) as compared to those under the Proposed Action. The unavoidable costs associated with SCR installation, Lease Amendment No. 1, and basic operating costs would account for a portion of the increase, but costs associated with curtailment and firming would account for the majority of the increases, particularly as the amount of energy provided by the Tribal PFR rises.

The effects of those differences would be most pronounced for entities that use CAP-delivered water for agricultural purposes (including the agricultural uses of CAP-affected tribes) as pumping costs are a major component of their costs. The likely impacts of those increases would comprise a minor to major impact for users. The higher energy costs under this alternative could negatively affect the economic feasibility of future sales of surplus energy yielding revenues to support the Development Fund. This could make it economically unjustifiable to purchase energy and power from NGS for the CAP.

3.20.4.6.6 Project Impact Summary – All Project Components

Navajo Nation and Hopi Tribe trust assets potentially affected by NGS under the Tribal PFR Alternative would include land and water. The effects on these Indian trust assets resulting from implementation of the Tribal PFR Alternative essentially would be the same as those associated with the Proposed Action. No negative impacts on Navajo Nation water or land trust assets would be anticipated for NGS from implementation of the Tribal PFR Alternative, and the beneficial effects of higher NGS-related payments to the Navajo Nation would be substantial.

Navajo Nation and Hopi Tribe trust assets affected by operations of the proposed KMC would include water, land, minerals, and hunting. Annual coal requirements for the Tribal PFR Alternative would be between 0.2 million and 0.4 million tons lower than those for the Proposed Action. The difference would be in addition to the 2.6 million tpy reduction associated with retirement of one unit with the 2-Unit Operation. Approximately 2 to 7 percent less surface disturbance could occur within the proposed KMC because less coal would be mined than under the Proposed Action. The lower coal production would reduce future royalty and bonus payments to the Navajo Nation and Hopi Tribe, although the revenues would remain substantial.

Water use and groundwater pumping effects at the proposed KMC essentially would be the same as those associated with the Proposed Action with the exception that impacts to groundwater levels and quality in shallow aquifers on the leasehold would be the same or slightly less than in a comparable Proposed Action due to a reduction in new mining disturbance and the potential for corresponding changes in mine configurations. Consequently, negligible to moderate impacts on Navajo Nation and Hopi Tribe water trust assets from KMC operations under the Tribal PFR Alternative would be anticipated.

Effects on Navajo and Hopi land trust assets essentially would be the same as under the Proposed Action with the exception that up to 7 percent less surface disturbance would occur because less coal would be mined. This could change the number of residents that would require relocation and the amount of grazing land that would be withdrawn. The mitigation and compensation strategies that would be provided and the steps that would be taken as part of decommissioning and reclamation would result in negligible to minor impacts to Navajo Nation and Hopi Tribe land trust assets under the Tribal PFR Alternative.

As noted above, annual coal requirements for the Tribal PFR Alternative would be between 0.2 million and 0.6 million tons lower than those for the Proposed Action. Over the period of extended operations between 2020 and 2044, royalty and bonus payments to the Navajo Nation and Hopi Tribe would total between $1.169 billion and $763 million. Negative impacts to Navajo Nation and Hopi Tribe mineral trust assets would be negligible under the Tribal PFR Alternative, and beneficial effects of continued coal royalties to the Hopi Tribe would be substantial.

Effects on Navajo Nation and Hopi Tribe hunting trust assets would be similar to those associated with the Proposed Action, except approximately 2 to 7 percent fewer hunting lands could be withdrawn during active mining. As with the Proposed Action, the vegetation mix on reclaimed lands would, be different than predisturbance conditions in some cases, resulting in negligible to minor impacts to Navajo Nation and Hopi Tribe hunting trust assets under the Tribal PFR Alternative.

Effects on Kaibab Band of Paiute Indians and Moapa Band of Paiute Indians trust land assets associated with the WTS transmission system and communication site would be limited to ongoing use of the land, for which the respective tribes are compensated by lease agreements. There would be no change in either the WTS or communication site easement use or in ongoing operation, maintenance, and repair activities; consequently, impacts to Indian trust assets would be negligible.

Although implementation of the Tribal PFR Alternative would not affect CAP-affected Tribes water rights trust assets, increases in the cost of CAP water and reductions in the availability of revenues for deposit to the Development Fund could affect the tribes' decisions regarding whether or not it would be economically viable to utilize their CAP water rights and contracted CAP water entitlements.

3.20.4.6.7 Cumulative Impacts

3.20.4.6.7.1 NGS and Associated Facilities

Cumulative effects on Navajo Nation water and land trust assets resulting from operations, decommissioning, and reclamation of NGS and past, present, or reasonably foreseeable future activities under the Tribal PFR Alternative would be the same as those associated with the Proposed Action.

3.20.4.6.7.2 Proposed Kayenta Mine Complex

Cumulative effects on Navajo Nation and Hopi Tribe water, land, and mineral trust assets resulting from implementation of the Tribal PFR Alternative for the proposed KMC would be similar to those associated with the Proposed Action. Minor differences would be associated with the lesser amounts of coal mined at the proposed KMC due to the replacement of an average of between 38 MW hours and 94.9 MW hours per hour over a typical 24-hour period under the Tribal PFR Alternative. Impacts to groundwater levels and quality in shallow aquifers on the leasehold would be the same or slightly less than under the Proposed Action due to a reduction in new mining disturbance and the potential for corresponding changes in mine configurations. Cumulative land use impacts on the proposed KMC would be the same as the Proposed Action except that 2 to 7 percent less surface disturbance could occur because less coal would be mined. This could result in fewer resident relocations and fewer grazing lands withdrawn for mining. Fewer Navajo and Hopi lands would be withdrawn from hunting access under the Tribal PFR Alternative, because a lesser amount of surface disturbance would occur. Over the period of extended operations from 2020 to 2044, royalty, bonus, and water payments to the Navajo Nation and Hopi Tribe would be lower under the Tribal PFR Alternative than under the Proposed Action. However, it would remain substantial and account for large portions of the budgets of both the Navajo Nation and the Hopi Tribe.

3.20.4.6.7.3 Transmission Systems and Communication Sites

Cumulative effects on Kaibab Band of Paiute Indians or Moapa Band of Paiute Indians land trust assets would be the same under the Tribal PFR Alternative as under the Proposed Action.

3.20.4.6.8 Central Arizona Project

Cumulative effects on water rights of tribes that have received CAP water entitlements would be the same for the Tribal PFR Alternative as under the Proposed Action. Cumulative effects of CAP pumping costs and reductions in contributions to the Development Fund associated with Colorado River water shortages would be greater than those associated with the Proposed Action.

3.20.4.7 No Action

3.20.4.7.1 Navajo Nation

3.20.4.7.1.1 Water

Under the No Action Alternative, NGS decommissioning activities would begin in 2018 conclude no later than December 22, 2019. The 1969 Lease requires that the "surface of any Reservation Lands modified or improved by the Lessees by the construction of access roads, dams, rail transportation facilities, surface pipelines, or other facilities constructed pursuant to this Lease or the 323 Grant for the plant site" be restored as closely as possible to their original condition.

A professional engineer would develop an industry-recognized and generally accepted good engineering practices closure plan. The USEPA regulations at the time of closure and lease requirements would be used as the basis for plant decommissioning and environmental demolition requirements.

Prior to decommissioning NGS, measures would be implemented consistent with the Groundwater Protection Plan, Perched Water Dewatering Plan, and Resource Conservation and Recovery Act requirements, including Phase I and II Environmental Site Assessments (and remediation as required), to ensure the groundwater quality has not been impaired. A long-term monitoring plan for groundwater quality, consistent with the USEPA's Coal Combustion Residuals rule, also would be implemented (Section 3.7 and **Appendix 1B**). Based on the findings of the water assessment conducted for the EIS (Section 3.7.4.2), no impacts to Navajo Nation trust water assets are anticipated to result from decommissioning and reclamation activities at NGS.

As described for No Action in Chapter 2.0, PWCC has indicated it would cease mining operations at the Kayenta Mine in 2019 and proceed to final reclamation of the Kayenta Mine, the former Black Mesa Mine, and all support facilities not otherwise approved as permanent facilities. Mine closure and reclamation would take place according to applicable permit documentation and provisions.

As noted in the No Action subsection of Section 3.7.4, N-Aquifer pumping would decline in 2019 from its current withdrawal rate of approximately 1,200 to 1,400 acre-feet per year. Pumping would continue for decommissioning operations, reclamation, local water supplies, and dust suppression. During the period 2020 through 2022, N-Aquifer pumping would decline to approximately 500 acre-feet per year.

Subsequent rates would be approximately 100 acre-feet per year during reclamation, which would be completed in approximately 2033. The Navajo Nation would continue to receive payment for water used during closure and reclamation.

The maximum predicted N-Aquifer drawdown under the No Action would be similar to, but less than, that depicted for the maximum predicted drawdown under the Proposed Action 3-Unit Operation. Maximum drawdown and percentage increases in pumping lift at key community wells would be similar to, but less than, those identified for the Proposed Action 3-Unit Operation (**Appendix WR-9**). Impacts to springs and stream baseflows also would be the same or less than those identified for the Proposed Action 3-Unit Operation. There would be no change in 2019 stream baseflows from mine-related pumping activities under the No Action or Proposed Action alternatives.

The net difference between Wepo Formation water availability and quality for existing uses under the No Action and Proposed Action alternatives would be negligible. No impacts to alluvial groundwater levels or quality would result from implementation of the No Action Alternative.

Consequently, no unmitigated or uncompensated negative impacts to Navajo Nation water trust assets would be anticipated under No Action. The Navajo Nation would forego the water fee revenues associated with the proposed KMC under the Proposed Action and other action alternatives.

3.20.4.7.1.2 Land

Section 2.3.1.3 describes the decommissioning and reclamation process for NGS. The operating and support facilities at the plant site would be dismantled and demolished to ground level over a multi-year period. The water supply facilities and certain buildings and equipment would remain, in accordance with the terms of the existing NGS Lease between the NGS Participants and the Navajo Nation. Except for hazardous materials and parts, and material salvaged, recycled, or sold for scrap, demolished structural material would be placed in a landfill area within the plant site and covered with soil. Hazardous materials would be transported and disposed of in compliance with Resource Conservation and Recovery Act and other applicable federal requirements. As required in the 1969 Lease, the land would be restored as closely as possible to original conditions on the surface of any trust lands modified or improved. The areas that do not contain permanent facilities would have all nonindigenous material removed from the surface, and the area would be filled and graded to provide proper drainage. No attempt would be made to return the leased lands or the ROWs to the preconstruction elevations. All restored land would be covered with topsoil indigenous to the area and revegetated as specified in the lease requirements.

Decommissioning and reclamation of the BM&LP Railroad would occur within or immediately adjacent to the existing ROW, the latter involving removal of fencing. Consequently, negligible impacts to Indian trust assets would be anticipated. In addition, decommissioning and reclamation would occur under the provisions of the existing 1969 Lease and 323 grants; therefore, negligible impacts to Indian trust assets within the remainder of the NGS lease area would be anticipated.

Under the No Action Alternative, the Navajo Nation would not receive lease or other payments for the use of land for NGS post-2019. Compared to the Proposed Action 3-Unit Operation, the No Action Alternative would result in foregone payments to the Navajo Nation totaling over $1.075 billion. Foregone revenues would total $793 million under the Proposed Action 2-Unit Operation.

Under the No Action Alternative, the Kayenta Mine would cease operations by the end of 2019. Mined land would be reclaimed pursuant to the approved reclamation plan and existing lease agreements. PWCC would restore the land with equal or greater forage productivity than pre-mining conditions (Section 3.14) or for other approved uses including wildlife habitat and cultural plants. After OSMRE and BIA have deteremined reclamation conditions are satisfactory, and following the release of bonds, control of the surface use would revert to the Navajo Nation. No homes would require relocation under the No Action Alternative and no grazing lands would be withdrawn for mining.

Site reclamation would be expected to take 2 to 3 years after cessation of mining. Mine facilities with economic value would be decommissioned and the materials removed for salvage. Non-salvageable facilities would be buried. Concrete foundations and sub-bases would be removed or buried in place if approved by OSMRE and the Navajo Nation. If the foundations were buried in place, the cover over these structures would be a minimum of 4 feet.

Disposition of mine facilities and lands affected by mining is expected to take approximately 10 to 15 years after mining ends to allow for the reclamation and bond release period (a minimum of 10 years after reclamation pursuant to Surface Mining Control and Reclamation Act requirements). Additional time could be required to meet revegetation standards and ensure long-term stability of reclaimed areas. Grading, topsoil replacement, and seeding would occur for facility areas as described in the approved permit application package. A reclamation bond would be maintained for the lands affected under the permanent program until final release.

Because decommissioning and reclamation would occur under OSMRE and tribal guidelines and the provisions of the existing lease for the Kayenta and former Black Mesa mines, no unmitigated impacts to Navajo Nation land trust assets within the lease area would be anticipated. The primary post-closure land uses would be livestock grazing and wildlife habitat, which would represent a restoration of pre-mining land uses.

3.20.4.7.1.3 Minerals

No additional coal would be mined under the No Action Alternative post 2019, and the Navajo Nation and Hopi Tribe would not receive royalty or bonus payments. Compared to the Proposed Action 3-Unit Operation, the No Action Alternative would result in foregone royalty and bonus payments to the Navajo Nation ranging from their 67 percent share of a total of $1.16 billion over the 25-year period from 2020 to 2044, under the 3-Unit Operation. Under the 2-Unit Operation, estimated total payments foregone would be $787 million.

3.20.4.7.1.4 Hunting

Reclaimed land would be returned to the Navajo Nation. Hunting, gathering, and other traditional land uses would resume at the discretion of the tribal government; consequently, negligible impacts to these Indian trust assets would be anticipated.

3.20.4.7.2 Hopi Tribe

3.20.4.7.2.1 Water

As described above, PWCC has indicated it would cease mining operations at the Kayenta Mine in 2019 and proceed to final reclamation of the Kayenta Mine, the former Black Mesa Mine, and all support facilities not otherwise approved as permanent facilities. Mine closure and reclamation would take place according to applicable permit documentation and provisions.

During the period 2020 through 2022, N-Aquifer pumping would decline to approximately 500 acre-feet per year. Subsequent rates would be approximately 100 acre-feet per year during reclamation, which would be completed in approximately 2033. The Hopi Tribe would continue to receive payment for water used during closure and reclamation.

The maximum predicted N-Aquifer drawdown under the No Action would be similar to, but less than, that depicted for the maximum predicted drawdown under the Proposed Action 3-Unit Operation. Maximum drawdown and percentage increases in pumping lift at key community wells would be similar to, but less than those identified for the Proposed Action 3-Unit Operation (**Appendix WR-9**). Impacts to springs and stream baseflows also would be the same or less than those identified for the Proposed Action 3-Unit Operation. There would be no change in 2019 stream baseflows from mine-related pumping activities under the No Action or Proposed Action alternatives.

The net difference between Wepo Formation water availability and quality for existing uses under the No Action and Proposed Action alternatives would be negligible. No impacts to alluvial groundwater levels or quality would result from implementation of the No Action Alternative.

Consequently, no unmitigated or uncompensated negative impacts to Hopi Tribe water trust assets would be anticipated under No Action. The Hopi Tribe would forego the water fee revenues associated with the proposed KMC under the Proposed Action and other action alternatives.

3.20.4.7.2.2 Land

As described above, the Kayenta Mine would cease operations by the end of 2019 under the No Action Alternative. Mined land would be reclaimed pursuant to the approved reclamation plan and existing lease agreements. PWCC would restore the land with equal or greater forage productivity than pre-mining conditions (Section 3.14) or for other approved uses including wildlife habitat and cultural plants. After the OSMRE and BIA determines reclamation to be satisfactory, and following the release of bonds, control of the surface use would revert to the Hopi Tribe.

Because decommissioning and reclamation would occur under OSMRE and tribal guidelines and the provisions of the existing lease for the Kayenta and former Black Mesa mines, no unmitigated impacts to Hopi Tribe land trust assets within the lease area would be anticipated. The primary post-closure land uses would be livestock grazing and wildlife habitat, which would represent a restoration of pre-mining land uses.

3.20.4.7.2.3 Minerals

No additional coal would be mined under the No Action Alternative, and the Navajo Nation and Hopi Tribe would not receive royalty or bonus payments. Compared to the Proposed Action 3-Unit Operation, the No Action Alternative would result in foregone royalty and bonus payments to the Hopi Tribe for its 33 percent share ranging from a total of $1.16 billion over the period from 2020 to 2044 under the 3-Unit Operation. Under the 2-Unit Operation, estimated total payments foregone would be $787 million.

3.20.4.7.2.4 Hunting

Reclaimed land would be returned to the Hopi Tribe. Hunting would resume at the discretion of the tribal government; consequently, negligible impacts to these Indian trust assets would be anticipated.

3.20.4.7.3 Kaibab Band of Paiute Indians

The NGS transmission system is an established part of the western U.S. transmission grid and supports reliability and delivery of power throughout the region, well beyond the power generated by the NGS. Therefore, under the No Action Alternative it is likely that that one, several, or all of the land owners/managers of the transmission line ROWs and communication site leases would renew some portion of the facilities to keep the power grid performing as expected.

In the event it is determined that some or all of the transmission systems and communication site ROWs are not renewed, a lengthy study and permitting process would need to occur before any decommissioning is initiated due to the essential and integral nature of these facilities with the western electric grid. As noted in Section 2.3.3, up to 4,826 acres within and alongside the transmission system corridors could be temporarily disturbed if the entirety of the transmission systems and communication sites were decommissioned and removed.

If, however, the segment of the WTS that crosses the Kaibab Band of Paiute Indians' trust lands is abandoned, the easement would revert to the Kaibab Band of Paiute Indians. If the communications site is decommissioned, the Kaibab Band of Paiutes would no longer receive an annual payment for the site.

3.20.4.7.4 Moapa Band of Paiute Indians

The NGS transmission system is an established part of the western U.S. transmission grid and supports reliability and delivery of power throughout the region, well beyond the power generated by the NGS. Therefore, under the No Action Alternative it is likely that that one, several, or all of the land owners/managers of the transmission line ROWs and communication site leases would renew some portion of the facilities to keep the power grid performing as expected.

In the event it is determined that some or all of the transmission systems and communication site ROWs are not renewed, a lengthy study and permitting process would need to occur before any decommissioning is initiated due to the essential and integral nature of these facilities with the western electric grid. As noted in Section 2.3.3, up to 4,826 acres within and alongside the transmission system corridors could be temporarily disturbed if the entirety of the transmission systems and communication sites were decommissioned and removed.

If, however, the segment of the WTS that crosses the Moapa River Indian Reservation is decommissioned, the Moapa Band of Paiute Indians would no longer receive annual compensation for its use.

3.20.4.7.5 CAP-affected Tribes

Implementation of the No Action Alternative would not affect water rights held by tribes who received CAP water through water settlements, which are held in trust by the federal government and are considered Indian trust assets.

Under the No Action Alternative, NGS power and energy would no longer be available to operate the CAP pumps. As system operator, Central Arizona Water Conservation District would continue to be responsible for obtaining the power necessary to deliver CAP water. Depending on market conditions and future prices of natural gas, CAP pumping energy costs under No Action could be between 23 percent less costly and 21 percent more costly compared to energy pumping costs under the Proposed Action. Due to the uncertainty regarding natural gas prices, future energy rates under No Action may be more variable over time than under the Proposed Action (**Table 3.18-78**).

Lower costs could benefit all users, in particular agricultural users and those tribes with CAP water allocations that devote most of their allocations to agriculture. Conversely, higher pumping energy costs effectively would raise the cost of water for users, including most of the tribes with CAP water allocations, and could affect water use. Surplus energy sales and revenues to support the Development Fund would cease under the No Action Alternative, regardless of whether pumping energy costs were higher or lower than those under the Proposed Action. Compensating for those reductions venues would require adjustments by CAP to fund debt service. The loss of surplus revenue sales could increase pumping energy rates on the order of $10 to $15 per acre-foot.

3.20.4.7.6 No Action Impact Summary – All Project Components

The provisions of the NGS and the Kayenta Mine lease agreements would ensure that decommissioning and reclamation occurred in compliance with applicable regulatory standards. Based on the lease agreements and the findings of the relevant EIS resource sections, no negative impacts to Navajo Nation or Hopi Tribe trust assets would be anticipated to result from closure, decommissioning, or reclamation activities. However, closure of NGS under the No Action Alternative would result in foregone payments to the Navajo Nation of over $1.075 billion under the Proposed Action 3-Unit Operation or $793 million under the Proposed Action 2-Unit Operation. Combined foregone revenues to the Navajo Nation and

Hopi Tribe associated with the proposed KMC under the No Action Alternative would total $1.16 billion over the period from 2020 to 2044 under the 3-Unit Operation and $787 million under the 2-Unit Operation.

If the WTS and communications sites were decommissioned on Kaibab Band of Paiute Indians or Moapa Band of Paiute Indians lands under the No Action Alternative, the tribes would. no longer receive annual compensation for use of those ROW segments.

Indian trust assets for tribes with CAP water allocations potentially affected by the No Action would be limited to existing water entitlements, which are held in trust by the federal government. Neither water entitlements nor the CAP's physical ability to deliver water to CAP-affected tribes would be affected by the No Action Alternative.

Future water costs would change under the No Action Alternative. Assuming replacement of NGS power with natural gas-generated power, CAP pumping energy costs under No Action could be between 23 percent less costly and 21 percent more costly compared to energy pumping costs under the Proposed Action. Due to the uncertainty regarding natural gas prices, future energy rates under No Action may be more variable over time than under the Proposed Action. Surplus energy sales and revenues to support the Development Fund would cease under No Action, which could increase CAP pumping energy rates on the order of $10 to $15 per acre-foot.

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Chapter 4.0

Mitigation and Voluntary Commitments

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Acronyms and Abbreviations

1969 Lease	Navajo Project Indenture of Lease
BART	Best Available Retrofit Technology
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BM&LP Railroad	Black Mesa & Lake Powell Railroad
BO	Biological Opinion
CAP	Central Arizona Project
CEQ	Council on Environmental Quality
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
CO_2	carbon dioxide
Co-tenants	Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
Development Fund	Lower Colorado River Basin Development Fund
EIS	Environmental Impact Statement
ERA	Ecological Risk Assessment
ESA	Endangered Species Act of 1973
HHRA	Human Health Risk Assessment
km	kilometer
KMC	Kayenta Mine Complex
kV	kilovolt
kW	kilowatt
MW	megawatt
N-Aquifer	Navajo Aquifer
NEPA	National Environmental Policy Act of 1969, as amended
NGO	non-government organization
NGS	Navajo Generating Station
NGS Participants	U.S. (Reclamation), Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
NHPA	National Historic Preservation Act
NNEPA	Navajo Nation Environmental Protection Agency
NO_2	nitrogen dioxide
NO_X	nitrogen oxide
OSMRE	Office of Surface Mining Reclamation and Enforcement
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 microns or less
PFR	Partial Federal Replacement
PWCC	Peabody Western Coal Company
Reclamation	U.S. Bureau of Reclamation
ROW	Right-of-way
SO_2	sulfur dioxide

SRP	Salt River Project Agricultural Improvement and Power District
STS	Southern Transmission System
U.S.	United States
USC	United States Code
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
WTS	Western Transmission System

Contents

4.0 Mitigation and Voluntary Commitments 4-1
4.1 Introduction 4-1
4.2 Best Management Practices 4-1
4.3 Proposed Mitigation Measures 4-2

List of Appendices

Appendix 4A - Conservation Measures

List of Tables

Table 4-1 Summary of Proposed Mitigation Measures for the NGS and KMC Project EIS 4-3

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4.0 Mitigation and Voluntary Commitments

4.1 Introduction

The Council on Environmental Quality (CEQ) (2011) states that "mitigation is an important mechanism Federal agencies can use to minimize the potential adverse environmental impacts associated with their actions. As described in the CEQ regulation, agencies can use mitigation to reduce environmental impacts in several ways. Mitigation includes:

- Avoiding an impact by not taking a certain action or parts of an action;
- Minimizing an impact by limiting the degree or magnitude of the action and its implementation;
- Rectifying an impact by repairing, rehabilitating, or restoring the affected environment;
- Reducing or eliminating an impact over time, through preservation and maintenance operations during the life of the action; and
- Compensating for an impact by replacing or providing substitute resources or environments."

This Environmental Impact Statement (EIS) includes Best Management Practices (BMPs) and proposed mitigation measures under the general category of mitigation. BMPs are existing policies, practices, and measures required by law, regulation, and voluntary NGS-participants and PWCC commitments that reduce the environmental impacts of designated activities, functions, or processes. BMPs are distinguished from mitigation measures because BMPs are existing requirements for the proposed action, and are ongoing, regularly occurring practices.

4.2 Best Management Practices

BMP descriptions are provided in this EIS by project component in appendices, or by reference to applicable federal regulations. The following is a summary of the BMPs that were considered as part of the impact assessment process.

<u>NGS and BM&LP Railroad</u>. The following BMP-related documents are included in **Appendix 1B** of this EIS:

- Navajo Project Operation and Maintenance Plan (April 2016). This document provides a summary of environmental management programs, and compliance activities that are required by federal agencies, and other agreements. The Environmental Regulations Requiring Compliance at NGS are summarized on Table 10. This table lists the agency regulation or permit, the regulated constituents, permit approval and renewal dates, and reporting requirements. BMPs and Mitigation Measures for the Navajo Project, which includes Navajo Generating Station (NGS) and the Black Mesa and Lake Powell (BM&LP) Railroad, are summarized in Appendix E to the Navajo Project Operation and Maintenance Plan (**Appendix 1B**). Measures are included for air quality; wildlife; threatened, endangered, and sensitive species; vegetation; noxious weeds; water quality; soil loss and erosion; cultural resources; health and safety; waste management; and recreation.
- Navajo Generating Station: Coal Combustion Residuals Ash Disposal Landfill Requirements. (July 2015). This document provides details for complying with the final rule to regulate Coal Combustion Residuals under Subtitle D of the Resource Conservation and Recovery Act. The primary component of this document is the Groundwater Protection Plan. The Plan describes the facilities that involve waste water containment, ditches, and landfills. The Plan then describes the shallow and deep groundwater monitoring wells, inspection and monitoring

programs, emergency contingency plans, and reporting. A Groundwater Monitoring Program Report (1978 to present) is an attachment to the Groundwater Protection Plan.

Kayenta Mine. The Office of Surface Mining Reclamation and Enforcement (OSMRE) administers the 1977 Surface Mining Controls and Reclamation Act (SMCRA) on all lands and coal leased from the Navajo Nation and Hopi Tribe on Black Mesa. The SMCRA legislation outlines the Permanent Program Standards (Code of Federal Regulations [CFR] Title 30 Mineral Resources, Subchapter K Permanent Program Standards, Parts 816.1 through 816.200). These standards include definitions of post-mining land use, and provide guidelines for soils and overburden management; use of explosives; surface water and groundwater management; revegetation suitability for soils and overburden; and revegetation success standards. PWCC provides annual reports to OSMRE that summarize reclamation progress across the mine, mine spoil monitoring for revegetation suitability, and surface water and groundwater quality monitoring at various locations within the lease area. In addition to the annual reports, PWCC provides air and groundwater monitoring reports on a quarterly basis. PWCC also maintains an air quality sampling network (**Appendix 1D** for sampling locations) which provide data for existing permits and permit renewals.

The USGS is engaged in a long-term groundwater, surface water, and water chemistry program on Black Mesa that was initiated in 1971. The program includes measurements of groundwater withdrawals, groundwater levels, spring discharges, surface-water discharges, and groundwater chemistry (Macy and Truini 2016). The results of this monitoring are summarized in periodic open-file reports.

STS and WTS Transmission Lines. BMPs for operation and maintenance activities (vegetation management, facility repairs) have been developed for both transmission line systems. Arizona Public Service Company, which operates the STS, has developed vegetation management plans (Appendix D to the Navajo Operation and Maintenance Plan, located in EIS **Appendix 1B**) that address the requirements of the Arizona State Land Department, BLM, U.S. Forest Service, the Navajo Nation and Hopi Tribe. Procedures for salvaging cacti, and protecting sensitive plants and animals and cultural resources are included for each land management jurisdiction. Best Management Practices and Mitigation Measures for the Navajo Project, which includes the STS and WTS, are summarized in Appendix E of the Navajo Project Operation and Maintenance Plan (**Appendix 1B**), as described above for the NGS and the BM&LP Railroad.

4.3 Proposed Mitigation Measures

For the purpose of this EIS, mitigation measures are additional, project specific measures proposed as a result of the NEPA environmental review process. Mitigation measures may specify resource protection actions, or may require monitoring, followed by a decision to take, or not take a protection action. Mitigation measures that are included in any Record of Decision (ROD) would become an integral part of the Proposed Action or alternative approved for implementation by the Secretary of the Interior. A Post-ROD Mitigation Monitoring Plan would be developed in conjunction with the ROD to track mitigation measure implementation.

Mitigation (Conservation Measures) for USFWS listed or candidate plant and animal species are contained in the Biological Assessment published concurrently with the Draft EIS. The same Conservation Measures are included in the applicable resource sections, and in **Appendix 4A**. It is anticipated that these Biological Assessment Conservation Measures, or Measures as modified, will be included in the USFWS Biological Opinion, which will be attached to the ROD. USFWS Biological Opinion is the definitive mitigation document for the affected species.

The NHPA Programmatic Agreements are treated as mitigation measures in this EIS; the details of cultural resources protection measures are included in the draft Programmatic Agreements located on (website). . The final Programmatic Agreements signed by the required parties are the definitive mitigation documents for cultural resources.

Table 4-1 provides a list of the proposed mitigation measures that have been included in the various EIS resource sections, with references to the chapter location where the measure text can be found.

Table 4-1 Summary of Proposed Mitigation Measures for the NGS and KMC Project EIS

NGS	Proposed KMC	WTS	STS	Mitigation Measure	Location in EIS
Paleontology					
	X			P-1 Identification and recovery of important fossils	3.5.4.3.2.3, 3.5,4.3.3.3
Wildlife – Special Status Species					
	X			AS-1 Mexican Spotted Owl Nesting Period Protection	3.11.4.3.2.3, **Appendix 4A**
		X	X	AS-2 Southwestern Willow Flycatcher Breeding and Nesting Protection	3.11.4.3.3.2, **Appendix 4A**
		X	X	AS-3 Western Yellow-billed Cuckoo Breeding and Nesting Protection	3.11.4.3.3.2, **Appendix 4A**
		X		RS-1 Mojave Desert Tortoise Individual and Habitat Protection	3.11.4.3.3.2, **Appendix 4A**
			X	RS-2 Sonoran Desert Tortoise Individual and Habitat Protection	3.11.4.3.3.2, **Appendix 4A**
Aquatic Biology – Special Status Fish Species					
X				FS-1 Non-native Fish Management in the Colorado River Grand Canyon Area	3.13.4.3.1.1, **Appendix 4A**
X				FS-2 Razorback Sucker Translocations	3.13.4.3.1.1, **Appendix 4A**
X				FS-3 Support Activities at the U.S. Fish and Wildlife Service Southwest Native Aquatics Research and Recovery Center	3.13.4.3.1.1, **Appendix 4A**
X				FS-4 Support Transport of Colorado Pikeminnow and Razorback Sucker above the Waterfall Barrier in the San Juan River	3.13.4.3.1.1, **Appendix 4A**
X				FS-5 Funding Support for a Habitat Improvement Project in the San Juan River	3.13.4.3.1.1, **Appendix 4A**
Cultural Resources					
X		X	X	Programmatic Agreement for the Navajo Generating Station, BM&LP Railroad, WTS and STS	**NGS PA**[1]
	X			Programmatic Agreement for the Kayenta Mine Complex	**KMC PA**[1]

[1] Posted on Project website (NGSKMC-EIS.net) when Draft EIS is released.

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Chapter 5.0

Short-term Uses versus Long-term Productivity

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Acronyms and Abbreviations

1969 Lease	Navajo Project Indenture of Lease
BART	Best Available Retrofit Technology
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BM&LP Railroad	Black Mesa & Lake Powell Railroad
BO	Biological Opinion
CAP	Central Arizona Project
CEQ	Council on Environmental Quality
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
CO_2	carbon dioxide
Co-tenants	Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
Development Fund	Lower Colorado River Basin Development Fund
EIS	Environmental Impact Statement
ERA	Ecological Risk Assessment
ESA	Endangered Species Act of 1973
HHRA	Human Health Risk Assessment
km	kilometer
KMC	Kayenta Mine Complex
kV	kilovolt
kW	kilowatt
MW	megawatt
N-Aquifer	Navajo Aquifer
NEPA	National Environmental Policy Act of 1969, as amended
NGO	non-government organization
NGS	Navajo Generating Station
NGS Participants	U.S. (Reclamation), Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
NHPA	National Historic Preservation Act
NNEPA	Navajo Nation Environmental Protection Agency
NO_2	nitrogen dioxide
NO_X	nitrogen oxide
OSMRE	Office of Surface Mining Reclamation and Enforcement
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 microns or less
PFR	Partial Federal Replacement
PWCC	Peabody Western Coal Company
Reclamation	U.S. Bureau of Reclamation
ROW	Right-of-way
SO_2	sulfur dioxide

SRP	Salt River Project Agricultural Improvement and Power District
STS	Southern Transmission System
U.S.	United States
USC	United States Code
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
WTS	Western Transmission System

Contents

5.0 Short-term Uses versus Long-term Productivity 5-1

5.1 Introduction 5-1

5.2 Air Quality and Climate 5-1

5.2.1 Proposed Action and Action Alternatives 5-1

5.2.2 No Action Alternative 5-2

5.3 Water and Water-Dependent Resources 5-2

5.3.1 Proposed Action and Action Alternatives 5-2

5.3.2 No Action Alternative 5-2

5.4 Soil and Biological Resources 5-2

5.4.1 Proposed Action and Action Alternatives 5-2

5.4.2 No Action Alternative 5-3

5.5 Land Use 5-3

5.5.1 Proposed Action and Action Alternatives 5-3

5.5.2 No Action 5-3

5.6 Socioeconomics 5-4

5.6.1 Proposed Action and Action Alternatives 5-4

5.6.2 No Action Alternative 5-4

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5.0 Short-term Uses versus Long-term Productivity

5.1 Introduction

The National Environmental Policy Act requires that an Environmental Impact Statement (EIS) include a discussion of the relationship between short-term uses of man's environment and maintenance and enhancement of long-term productivity (40 Code of Federal Regulations 1502.16). The following are definitions, or assumptions used to conduct this analysis.

- The primary resource-related activities at Kayenta Mining include coal extraction and follow-on reclamation, and withdrawal of groundwater for dust control and other uses. The primary resource-related activities at Navajo Generating Station (NGS) include withdrawal of cooling water from Lake Powell, coal combustion to generate electricity, disposal of coal combustion residuals in a landfill, and evaporation of waste water in cooling towers and in ponds. The workforces that operate both facilities represent the primary human resource activities.
- Natural and human resource impacts from implementation of the Proposed Action and the Alternatives are described in Chapter 3.0.
- Short-term for this EIS is defined as period of 2 years or less, which generally corresponds to the time required to stabilize disturbed soils and initiate revegetation.
- Long-term for this EIS is defined as the operating period for NGS-Kayenta Mine Complex (KMC) Project components, and the additional time required for project impacts to be reduced to levels similar to background conditions. Both NGS and the Kayenta Mine represent long-term operations.
- For renewable resources (e.g., biological resources), productivity means the rate at which quantities of a resource (for example, the weight of new plant growth or biomass) are added (input) to an ecosystem. In economic terms, productivity is a measure of how efficiently inputs, such as labor and natural resources, are being used in an economy to produce a given output of goods and services.
- The Western Transmission System, Southern Transmission System, and associated communication sites would continue to operate through 2044, and likely beyond. No new modifications to this system would occur; only operation and maintenance activities would occur along the rights-of-way on an infrequent basis. As a consequence, the influence of short-term uses on long-term productivity is not relevant for these project components.

For purposes of evaluating project effects on long-term productivity, all the action alternatives are evaluated together because of the operational differences are small. The No Action Alternative is discussed separately. The following resources are discussed in this section because long-term productivity impacts are expected.

5.2 Air Quality and Climate

5.2.1 Proposed Action and Action Alternatives

NGS and the Kayenta Mine would continue to generate emissions of various air pollutants over the remaining life of both facilities. As described in Section 3.1, Air Quality, both components currently operate, and are expected to operate within regulatory limits for emissions and consequent atmospheric concentrations of criteria and hazardous air pollutants. These emissions are not expected to reduce long term productivity because air quality standards were developed to be protective of natural resource and human health.

As described in Chapter 3.2, Climate Change, the project would emit greenhouse gases at a maximum rate of approximately 18.3 million metric tons of carbon dioxide equivalent annually through 2044. Greenhouse gas emissions would be slightly lower under the partial replacement alternatives than under the Proposed Action. These emissions are predicted to contribute to climate change, indicated by increases in global temperature and greater variability in precipitation at various geographic scales. The aquatic and terrestrial ecosystems, and agricultural crops and livestock forage may respond to climate changes in different ways as described in Section 3.2, which could result in both increased and decreased productivity.

5.2.2 No Action Alternative

The operational emissions from NGS and Kayenta Mine would cease in 2018, thereby eliminating more than 25 years of greenhouse gas emissions from these facilities. Global, regional, and local increases in greenhouse gases from other sources are predicted to continue (Section 3.2), with consequent productivity changes in natural and agricultural systems.

5.3 Water and Water-Dependent Resources

5.3.1 Proposed Action and Action Alternatives

NGS would continue to use up to 40,000 acre feet of water per year from Lake Powell, and the proposed KMC would require approximately 1,200 acre feet of groundwater per year through 2044. Based on the analysis provided in Section 3.7, Water Resources, and Section 3.12, Aquatic Resources, the NGS withdrawals would not reduce the productivity of aquatic resources within Lake Powell. At the proposed KMC, the retention and maintenance of impoundments over the long term would provide reliable water for wildlife and livestock, a productivity benefit. Based on the analysis provided in Section 3.7, the project withdrawal of groundwater would result in no or negligible reductions in spring flows and base flows in channels that drain Black Mesa, and therefore the productivity of water dependent resources (riparian vegetation and wildlife habitat) would be maintained. Cumulative reductions in channel base flows are predicted (**Appendix WR-9**) when past pumping (community and mine), future KMC, and future community pumping are considered together, and therefore there may be a slight decline in riparian vegetation productivity within the major Black Mesa drainages. See Section 5.6 for a discussion of community well drawdown impacts from mine pumping.

5.3.2 No Action Alternative

NGS water demands from Lake Powell would cease after decommissioning is completed in 2020, and groundwater withdrawals at proposed KMC would decline to 500 acre-feet per year during a reclamation period extending for 10 to 15 years after 2018. Future cumulative reductions in Black Mesa channel base flows are predicted (**Appendix WR-9**) in the absence of proposed KMC pumping because the continuing aquifer drawdown impacts of past pumping, combined with foreseeable community pumping, would result in slight declines in riparian vegetation productivity.

5.4 Soil and Biological Resources

5.4.1 Proposed Action and Action Alternatives

Land productivity on approximately 3,724 acres at the NGS plant site and railroad right-of-way would be restored as the result of decommissioning and revegetation after 2044. The time required for vegetation recovery to a level similar to background conditions would be long-term because of low and variable annual precipitation.

Areas disturbed by proposed KMC mining would be progressively revegetated. At the completion of mining in 2044, surface facilities such as conveyors, buildings, and roads, would be decommissioned and removed. A total of 10,123 acres of previously disturbed land would remain to be revegetated after

2044, requiring 10 to 15 years before control of the land is returned to the Navajo Nation or Hopi Tribe. The long-term productivity of revegetated land is expected to match or be higher than that for pre-existing vegetation communities because soil and overburden would be mixed to provide suitable growing medium for revegetation species.

Wildlife habitat would be predominantly suitable for grassland species, with an increasing shrubland habitat component over the long-term. Restoration of woodlands (pinyon pine-juniper) would be very long term (greater than 50 years). In summary, the productivity of wildlife habitats would be maintained or increased, but the support functions would be different (less overall ground cover by woody vegetation).

Based on the ecological risk analysis conducted for wildlife and aquatic communities, and special status species (Sections 3.8 through 3.13), the long-term productivity of the terrestrial and aquatic communities receiving trace metal deposition from NGS stack emissions through 2044 would be maintained. When cumulative sources of trace metal deposition and baseline water quality conditions are considered, reductions in the productivity of special status fish species are predicted in segments of the Lower Colorado River (humpback chub and razorback sucker) and San Juan River (Colorado pikeminnow and razorback sucker). Mitigation measures have been proposed to improve survival and reproduction for these species (Section 3.13).

5.4.2 No Action Alternative

Under the No Action Alternative, decommissioning activities at NGS and proposed KMC would occur in 2018 to 2019, and previously disturbed areas would be revegetated. Less time would be required for vegetation productivity to recover as compared to the Proposed Action and Action Alternatives. Trace metal deposition from NGS stacks would cease, but cumulative impacts to the productivity of special status fish in the Colorado River system would continue, based on trace metal deposition rates from other regional and global sources.

5.5 Land Use

5.5.1 Proposed Action and Action Alternatives

The industrial land use would continue, largely unchanged at NGS through 2044. As described above under Soils and Biological Resources, proposed KMC mining would progressively remove native vegetation communities, followed by reclamation of disturbed areas. Access for grazing to areas undergoing reclamation would be restricted. Over the long-term, revegetated land would be returned to the Navajo Nation or Hopi Tribe. The appropriate tribal agency in turn would allocate the revegetated land to community members for the purpose of livestock grazing and other uses. In summary, economic productivity related to natural resources uses (grazing land) by community members on the proposed KMC would be reduced during the 2020 to 2044 period to accommodate continued mining, and ongoing land reclamation. It is expected that economic productivity based on livestock grazing would increase after community members gain full access to reclaimed lands.

5.5.2 No Action Alternative

Industrial land uses at NGS and proposed KMC would cease in 2018 to 2019, with decommissioning and reclamation as described above. The effect on natural productivity would be less time required to meet reclamation productivity goals, and less time for the land to be suitable for intended future uses (primarily livestock grazing).

5.6 Socioeconomics

5.6.1 Proposed Action and Action Alternatives

The socioeconomic benefits of power plant and mine related employment would extend through 2044, and then would substantially decline during decommissioning and the final reclamation period. No comparable source(s) of employment and income for power plant and mine workers currently exist or are anticipated to develop in the region. Lease fees, mine royalties and other payments to the tribes and local counties would cease after 2044. Other costs to the Navajo Nation, Hopi Tribe, and affected counties are expected to increase, including costs for employee assistance and education programs, and greater demands for social and medical services as the result of increased unemployment. The overall impact would be an overall reduction in economic productivity because of lowered economic outputs (payrolls and payments), and increased costs to support unemployed workers and their families.

Mine-related pumping would result in long-term groundwater drawdown of less than 50 feet in community wells near the proposed KMC, which would slightly increase pumping costs over the next 50 years.

Proposed Action Central Arizona Project (CAP) pumping cost increases from 2020 levels would range from $12 to $14 per acre-foot in 2044 due to the Proposed Action; implementation of the most expensive alternative would increase the acre foot pumping cost in 2044 by $45 per acre-foot relative to the Proposed Action. Changes in the cost of water could alter decisions on CAP water distribution among agricultural, industrial, municipal, and groundwater recharge uses.

5.6.2 No Action Alternative

Production at NGS and proposed KMC would cease in 2018, with decommissioning and reclamation as described above. The socioeconomic impacts on employment, income, unemployment and support for tribal and local government operations would occur earlier in time, with the impacts of unemployment also occurring earlier. Community pumping costs are anticipated to increase in the future because the continued community N-Aquifer drawdowns would offset the aquifer recovery associated with cessation of mine pumping.

Alternative energy sources for CAP pumping would need to be acquired or constructed, or contracts signed for power purchases. Assuming a power purchase agreement for the equivalent of NGS power, the cost per acre-foot is projected to be from $10 less to $17 more relative to the Proposed Action in 2020, depending on future prices of natural gas (**Table 3.18-83**). In summary, the impacts on economic productivity for the Navajo Nation and Hopi Tribe would occur earlier in time; the economic productivity related to CAP pumping costs may be influenced by a wide range of future natural gas market costs. Changes in the cost of water could alter future use of CAP water among agricultural, industrial, municipal and groundwater recharge.

Chapter 6.0

Irretrievable and Irreversible Commitment of Resources

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Acronyms and Abbreviations

1969 Lease	Navajo Project Indenture of Lease
BART	Best Available Retrofit Technology
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BM&LP Railroad	Black Mesa & Lake Powell Railroad
BO	Biological Opinion
CAP	Central Arizona Project
CEQ	Council on Environmental Quality
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
CO_2	carbon dioxide
Co-tenants	Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
Development Fund	Lower Colorado River Basin Development Fund
EIS	Environmental Impact Statement
ERA	Ecological Risk Assessment
ESA	Endangered Species Act of 1973
HHRA	Human Health Risk Assessment
km	kilometer
KMC	Kayenta Mine Complex
kV	kilovolt
kW	kilowatt
MW	megawatt
N-Aquifer	Navajo Aquifer
NEPA	National Environmental Policy Act of 1969, as amended
NGO	non-government organization
NGS	Navajo Generating Station
NGS Participants	U.S. (Reclamation), Salt River Project, Arizona Public Service Company, NV Energy, and Tucson Electric Power Company
NHPA	National Historic Preservation Act
NNEPA	Navajo Nation Environmental Protection Agency
NO_2	nitrogen dioxide
NO_X	nitrogen oxide
OSMRE	Office of Surface Mining Reclamation and Enforcement
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 microns or less
PFR	Partial Federal Replacement
PWCC	Peabody Western Coal Company
Reclamation	U.S. Bureau of Reclamation
ROW	Right-of-way
SO_2	sulfur dioxide

SRP	Salt River Project Agricultural Improvement and Power District
STS	Southern Transmission System
U.S.	United States
USC	United States Code
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
WTS	Western Transmission System

Contents

6.0 Irretrievable and Irreversible Commitment of Resources 6-1

List of Tables

Table 6-1 NGS-KMC Project Irretrievable and Irreversible Commitment of Resources for the Proposed Action and Alternatives. 6-1

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6.0 Irretrievable and Irreversible Commitment of Resources

Irretrievable and irreversible resource commitments are related to the use of nonrenewable and renewable resources, and the effects that the uses of these resources would have on availability for future generations. Irretrievable commitments apply primarily to the use of nonrenewable resources that cannot be replenished such as fossil fuels, paleontological and cultural resources. Irreversible commitments primarily result from the use or loss of a specific resource that cannot be replaced within a reasonable time. Irreversible commitments are represented by potential losses of future options for resource development or management. An example would be protection of high value surface resources (such as cultural resources) that preclude access to underlying minerals.

The irretrievable and irreversible commitments of resources for the Proposed Action and alternatives are considered similar in scale, and are discussed together.

Table 6-1 provides a summary of irretrievable and irreversible commitments of resources

Table 6-1 NGS-KMC Project Irretrievable and Irreversible Commitment of Resources for the Proposed Action and Alternatives.

Resource	Irretrievable	Irreversible	Interpretation
Air Quality	Yes	Yes	The constituent gases of the atmosphere are considered nonrenewable resources. NGS combustion emissions represent irretrievable additions to regional and global atmospheric concentrations of various criteria pollutants and greenhouse gases. These additions are irreversible because they become permanent constituents of the atmosphere, or are removed very slowly by natural processes.
Geological and Mineral Resources	Yes	Yes	Mining and combustion of coal would be both irretrievable and irreversible commitments of resources because coal is a nonrenewable fossil fuel.
Paleontological Resources	Yes	Yes	Paleontological resources removed by surface disturbance would be both irretrievable and irreversible commitments of resources because fossil bearing formations are nonrenewable.
Water Resources	No	No	The storage and release of surface water originating from annual rainfall does not represent a irretrievable or irreversible commitment of resources. Groundwater withdrawal in an arid climate may be irretrievable if recharge is non-existent or extremely slow. There is evidence of aquifer recovery from past and present pumping on Black Mesa, and therefore groundwater commitments are not irreversible, but recovery rates are long-term.
Soil Resources	Yes	No	Soil removal and mixing from surface disturbance is an irretrievable resource commitment because soil cannot be replaced in its original form. However, the productivity of soil can be maintained and enhanced from proper soil storage and reapplication over disturbed areas.

Table 6-1 NGS-KMC Project Irretrievable and Irreversible Commitment of Resources for the Proposed Action and Alternatives.

Resource	Irretrievable	Irreversible	Interpretation
Vegetation Resources	Yes	No	Vegetation removal from surface disturbance is an irretrievable resource commitment because all elements of the existing vegetation community cannot be replaced because of intolerance of some species to soil disturbance. The productivity and diversity of vegetation communities over the long term may be restored with proper management, even though the species composition of these communities may be different from the pre-existing community.
Wildlife Resources	Yes	No	Wildlife habitat removal is an irretrievable resource commitment because the pre-existing components of habitat and structure cannot be comprehensively replaced. Restored vegetation communities may provide suitable habitat over the long term for a variety wildlife species, but the wildlife species composition and abundance may be different from the pre-existing habitat areas.
Aquatic Resources	No	No	The operation of project components are not expected to measurably change the composition and abundance of aquatic resources in Lake Powell and on Black Mesa, and therefore irretrievable and irreversible resource commitments are not anticipated.
Cultural Resources	Yes	Yes	Damage and loss of cultural resources are irretrievable and irreversible resource commitments because cultural resources are not replaceable.
Socioeconomics	Yes	Yes	Operation of the two facilities would require the commitment of natural, human, engineered, and monetary resources. Once completed, most of the resource investments would be irretrievable and their use/application for this project would preclude or foreclose their use for other purposes. Other economic enterprises that would be able to utilize these human and infrastructural resources are lacking in the project area; without other economic opportunities, community members would see employment opportunities elsewhere and would not be available as a labor source, resulting in an irreversible commitment.

Chapter 7.0

Consultation and Coordination

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Acronyms and Abbreviations

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BLM	Bureau of Land Management
BM&LP Railroad	Black Mesa & Lake Powell Railroad
BO	Biological Opinion
CAP	Central Arizona Project
CEQ	Council on Environmental Quality
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
CO_2	Carbon dioxide
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Development Fund	Lower Colorado River Basin Development Fund
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Reclamation	Bureau of Reclamation
ROW	Right-of-way

SO_2	Sulfur dioxide
SRP	Salt River Project Agricultural Improvement and Power District
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U.S.	United States
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Contents

7.0 Consultation and Coordination 7-1
7.1 Consultation and Coordination 7-1
7.1.1 Cooperating Agencies 7-1
7.1.2 Government-to-Government Consultation 7-4
7.1.3 Formal Consultation 7-5
7.1.3.1 Biological Resources 7-5
7.1.3.2 Cultural Resources 7-7
7.1.4 Air Quality Subgroup 7-8
7.2 Public Review of the Draft EIS 7-8
7.2.1 Distribution List of the Draft EIS 7-9

List of Tables

Table 7-1 Cooperating Agency Interaction 7-2
Table 7-2 Government–to–Government Tribal Consultations to Date 7-4
Table 7-3 Information Provided by Tribe or Agency Regarding Listed Species in the Project Area 7-6
Table 7-4 Summary of Cultural Resources Update Meetings 7-8

7.0 Consultation and Coordination

During the scoping process, and consultation and coordination throughout the preparation of this Environmental Impact Statement (EIS), formal and informal efforts were made by the U.S. Bureau of (Reclamation) to involve other federal agencies, state, and local governments, tribes, and the public. Consultation and coordination with federal and intergovernmental agencies, organizations, Native American tribes, and interested groups and individuals is important to (1) ensure the most appropriate data have been gathered and employed for analyses and (2) ensure that agency and public interests and values are considered by decision makers. The sections of this chapter describe the consultation and coordination efforts for this EIS including informal consultation and coordination, required formal consultation, and public participation activities other than Public Scoping. Public outreach activities conducted during the scoping period are summarized in Section 1.10; Public Scoping. Additional information is available in the Scoping Summary Report, available at http://ngskmc-eis.net/scoping-summary-report-files/.

7.1 Consultation and Coordination

Coordination and collaboration on the EIS were accomplished through written and telephone communication, meetings, and other cooperative efforts between Reclamation and interested federal, state, and local government agencies, tribes, organizations, other interest groups, and the public.

7.1.1 Cooperating Agencies

Federal, state, and local agencies, and Native American tribes that may have an interest in the Navajo Generating Station (NGS)-Kayenta Mine Complex (KMC) Project EIS were invited to participate in the preparation of the EIS as cooperating agencies. A cooperating agency is any federal, state, or local government agency or Native American tribe that has either jurisdiction by law or special expertise regarding environmental impacts of a proposal or a reasonable alternative for a major federal action affecting the quality of the human environment. The benefits of cooperating agency participation in the analyses for and preparation of this EIS include (1) disclosure of relevant information early in the analytical process; (2) application of available technical expertise and staff support; (3) avoidance of duplication of other federal, tribal, state, and local procedures; and (4) establishment of a mechanism for addressing intergovernmental issues.

Due to the substantial jurisdictional responsibilities of both Office of Surface Mining Reclamation and Enforcement's (OSMRE's) Western Region and Bureau of Indian Affairs' (BIA's) Navajo Region, these two agencies were defined as key cooperating agencies.

As detailed in **Table 7-1**, in February and March of 2013, Reclamation sent formal letters inviting 10 federal entities to participate as cooperating agencies in the preparation of the NGS-KMC Project EIS and received 7 positive responses.

In January of 2014, Reclamation sent formal letters inviting the Hopi Tribe and Navajo Nation, and in April of 2014 invited the 10 tribes with Central Arizona Project (CAP) water allocations (Ak Chin Indian Community, Fort McDowell Yavapai Nation, Gila River Indian Community, Pascua Yaqui Tribe, Salt River Pima-Maricopa Indian Community, San Carlos Apache Tribe, Tohono O'odham Nation, Tonto Apache Tribe, White Mountain Apache Tribe, and Yavapai-Apache Nation) to participate as cooperating agencies. In March and June of 2014, the Navajo Nation, and the Gila River Indian Community, respectively, accepted the invitation to become cooperating agencies.

In April of 2014, Reclamation sent a formal letter inviting the Central Arizona Water Conservation District to participate as a cooperating agency and received a positive response in May 2014. In addition, the Arizona Department of Game and Fish requested cooperating agency status in April of 2014.

Reclamation sent a formal letter acknowledging the Arizona Department of Game and Fish as a cooperating agency in May of 2014.

Table 7-1 Cooperating Agency Interaction

Agency	Invitation Date	Acceptance Date	Cooperating Agency Status	Jurisdiction/Special Expertise for this EIS
OSMRE–Western Region	03/06/2013	03/13/2013	Key Cooperating Agency	Act as key cooperating agency per Memorandum of Understanding among Reclamation, OSMRE, BIA, and the project proponents. Review EIS regarding compliance with OSMRE requirements; ensure all information is adequate to issue a Record of Decision based on the Final EIS analysis.
Bureau of Indian Affairs - Navajo Region	03/06/2013	03/18/2014	Key Cooperating Agency	Act as key cooperating agency per Memorandum of Understanding among Reclamation, OSMRE, BIA, and the project proponents. Review EIS regarding compliance with BIA requirements; ensure all information is adequate to issue a Record of Decision based on the Final EIS analysis.
Bureau of Land Management	02/12/2014	04/14/2014	Cooperating Agency	Act as cooperating agency per Memorandum of Understanding between Reclamation and Bureau of Land Management.
BIA Western Region	02/12/2014	05/12/2014	Cooperating Agency	Act as cooperating agency per Memorandum of Understanding between Reclamation and BIA – Western Region.
U.S. Fish and Wildlife Service (USFWS)	02/12/2014	03/06/2014	Cooperating Agency	Act as cooperating agency per Memorandum of Understanding between Reclamation and USFWS.
National Park Service	02/12/2014	04/07/2014	Cooperating Agency	Act as cooperating agency per Memorandum of Understanding between Reclamation and National Park Service.
U.S. Department of Labor Mine Safety and Health Administration	02/12/14	—	No Response	N/A
U.S. Environmental Protection Agency	02/12/2014	04/02/2014	Cooperating Agency	Act as cooperating agency per letter dated May 28, 2014. Review EIS for compliance with applicable federal environmental regulations.
Department of Energy – Western Area Power Administration	02/12/2014	Declined - 04/02/2014	Declined Cooperating Agency Status	N/A
Department of Agriculture - U. S. Forest Service	02/12/2014	04/07/2014	Cooperating Agency	Act as cooperating agency per Memorandum of Understanding between Reclamation and U.S. Forest Service.

Table 7-1 Cooperating Agency Interaction

Agency	Invitation Date	Acceptance Date	Cooperating Agency Status	Jurisdiction/Special Expertise for this EIS
Navajo Nation	01/30/2014	03/31/2014	Cooperating Agency	Act as cooperating agency per Memorandum of Understanding between Reclamation and the Navajo Nation.
Hopi Tribe	01/30/2014	None	No Response	Invited to act as cooperating agency per Memorandum of Understanding between Reclamation and the Hopi Tribe.
Ak Chin Indian Community	05/23/2014	—	No Response	CAP-affected Tribe
Fort McDowell Yavapai Nation	05/23/2014	—	No Response	CAP-affected Tribe
Gila River Indian Community	05/23/2014	06/03/2014	Cooperating Agency	Act as cooperating agency per Memorandum of Understanding between Reclamation and Gila River Indian Community.
Pascua Yaqui Tribe	05/23/2014	—	No Response	CAP-affected Tribe
Salt River Pima-Maricopa Indian Community	05/23/2014	—	No Response	CAP-affected Tribe
San Carlos Apache Tribe	05/23/2014	—	No Response	CAP-affected Tribe
Tohono O'odham Nation	05/23/2014	—	No Response	CAP-affected Tribe
Tonto Apache Tribe	05/23/2014	—	No Response	CAP-affected Tribe
White Mountain Apache Tribe	05/23/2014	—	No Response	CAP-affected Tribe
Yavapai-Apache Nation	05/23/2014	—	No Response	CAP-affected Tribe
Pueblo of Zuni	03/23/2016	04/07/2016	Cooperating Agency	Act as cooperating agency per Memorandum of Understanding between Reclamation and the Pueblo of Zuni.
Arizona Game and Fish Department	10/02/2014	01/20/15	Cooperating Agency	Act as cooperating agency per Memorandum of Understanding between Reclamation and the Arizona Game and Fish Department.
Central Arizona Water Conservation District	4/10/2014	05/29/14	Cooperating Agency	Act as cooperating agency per Memorandum of Understanding between Reclamation and the Central Arizona Water Conservation District.

An initial cooperating agencies' meeting was held on June 13, 2013, to outline the EIS process and provide background on the Proposed Action, including a preview of the EIS issues. The project team was introduced and an initial project schedule was presented. In addition:

- Information was provided to federal agencies and tribes to assist in their decision whether to become Cooperating Agencies;
- The Technical Work Group process was initiated; and
- A plan for periodic project communications was established.

A second cooperating agency meeting was held on October 29, 2014 to update the agencies on the project process and schedule and to provide additional information on subgroup processes and other occurrences.

A third cooperating agency meeting was held on May 26, 2016 to provide information on the preliminary draft EIS released for cooperating agency review on that day. The meeting kicked-off a 30-day review period with an update of the project progress and a question and answer session.

7.1.2 Government-to-Government Consultation

The United States (U.S.) has a unique legal relationship with Native American tribal governments as set forth in the Constitution of the U.S., treaties, Executive Orders, federal statues, federal policy, and tribal requirements, which establish the interaction that must take place between federal and tribal governments. The most important basis for this relationship is the trust responsibility of the U.S. to protect tribal sovereignty, self-determination, tribal lands, tribal assets and resources, and treaty and other federally recognized and reserved rights. Federal agencies work with tribes, government-to-government, to address issues concerning Indian tribal self-government, tribal trust resources, and Indian tribal treaty and other rights. Government-to-government consultation is the process of seeking, discussing, and considering views on environmental and cultural resource management issues. The Department of the Interior Policy on Consultation with Indian Tribes (U.S. Department of the Interior 2011) and Reclamation's Protocol Guidelines: Consulting with Indian Tribal Governments (Reclamation 2012) contain consultation and coordination procedures to guide Reclamation's interaction with the tribes.

In addition to status as cooperating agencies, Reclamation requested formal government-to-government consultation with the Navajo Nation, Hopi Tribe, Zuni Tribe, and 10 tribes that have Central Arizona Project water allocations (CAP-affected tribes)).

Reclamation has conducted government-to-government tribal consultation as detailed in **Table 7-2**. Additional government-to-government tribal consultations and informal tribal consultations will occur at key project stages and as requested by tribal governments.

Table 7-2 Government–to–Government Tribal Consultations to Date

Tribe	Date	Location	Agencies Represented
Navajo	March 31, 2014	Window Rock, Arizona	Reclamation, OSMRE, BIA-Navajo Region
	July 21, 2015	Window Rock, Arizona	Reclamation, OSMRE, BIA-Navajo Region
	July 19, 2016	Window Rock, Arizona	Reclamation, OSMRE, BIA- Navajo Region
Hopi	May 16, 2014	Kykotsmovi, Arizona	Reclamation, OSMRE
	May 15, 2015	Kykotsmovi, Arizona	Reclamation, OSMRE
	March 7, 2016	Kykotsmovi, Arizona	Reclamation, OSMRE
	June 22, 2016	Kykotsmovi, Arizona	Reclamation, OSMRE, BIA-Western Region

Table 7-2 Government–to–Government Tribal Consultations to Date

Tribe	Date	Location	Agencies Represented
CAP-affected Tribes	May 15, 2014	Phoenix, Arizona	Reclamation, BIA-Western Region
	April 14, 2015	Phoenix, Arizona	Reclamation
Kaibab Band of Paiute Indians	July 3, 2014	Pipe Spring, Arizona	Reclamation, OSMRE, BIA-Western Region
	April 16, 2015	Pipe Spring, Arizona	Reclamation
	February 18, 2016	Pipe Spring, Arizona	Reclamation
Hualapai	March 4, 2016	Peach Springs, Arizona	Reclamation
Pueblo of Zuni	February 16, 2016	Zuni, New Mexico	Reclamation, OSMRE

7.1.3 Formal Consultation

Reclamation is required to prepare EISs in coordination with any studies or analyses required by the Fish and Wildlife Coordination Act (16 United States Code [USC] Sec 661 et seq. [16 USC 661]), Endangered Species Act of 1973 (16 USC Sec 1531 et seq. [16 USC 1531]), and the National Historic Preservation Act of 1966, as amended (16 USC Sec 470 et seq. [16 USC 470]). Early in the preparation of the EIS, the cooperating agencies suggested and agreed to work collaboratively in the consultations for Section 7 of the Endangered Species Act and Section 106 of the National Historic Preservation Act. The following sections are summaries of the activities associated with the consultation processes to date for threatened and endangered species and cultural resources.

7.1.3.1 Biological Resources

In accordance with the Endangered Species Act of 1973, as amended, 16 USC 1531 et seq., formal consultation is required when the action agency determines that the proposed action may affect a listed species or designated critical habitat. The consultation process determines whether the proposed action is likely to jeopardize the continued existence of a species or destroy or adversely modify critical habitat. The process begins with Reclamation's written request and a submittal of a completed biological assessment (BA), and concludes with the issuance of a biological opinion from the USFWS, which may include an incidental take statement or a letter of concurrence from USFWS (if USFWS agrees that the proposed project would have no effect or would not adversely affect a threatened or endangered species or their critical habitat). On February 12, 2015, Reclamation sent a letter to the USFWS Arizona Ecological Services Office requesting confirmation of a draft list of federally listed species that may be affected by the NGS-KMC Project. Reclamation also contacted the following agencies regarding the occurrence of special status species in the NGS-KMC Project areas: USFS (Kaibab National Forest, Prescott National Forest), BLM, Navajo Nation, Hopi Tribe, Kaibab Band of Paiute Indians, Moapa Band of Paiute Indians, and Arizona Game and Fish Department. Species occurrence information also was obtained from Arizona Game and Fish Department Project Evaluation Program, Utah Division of Wildlife Resources Natural Heritage Program, and Nevada Natural Heritage Program. Responses and accompanying information received are summarized in **Table 7-3**.

Table 7-3 Information Provided by Tribe or Agency Regarding Listed Species in the Project Area

Tribe/Agency	Date of Response	Information Provided
U.S. Fish and Wildlife Service	March 11, 2015	Confirmation, with revisions, of list of threatened, endangered, proposed, candidate, and conservation agreement species to be analyzed in the NGS-KMC BA.
U.S. Forest Service	April 25, 2014	Meeting with the Kaibab and Prescott National Forests to receive input on special status and management indicator species (MIS) known or with potential to occur along the STS.
Bureau of Land Management	November 19, 2015 December 2, 2015	BLM Field Office-specific lists of BLM-designated sensitive species with potential to occur on BLM-administered lands along the WTS and STS.
Navajo Nation	March 25 and October 29, 2014	Received special status species occurrence information in a letter and meeting for the proposed KMC and STS study areas.
Hopi Tribe	May 19, 2014	Input (received during meeting) on sensitive species with potential to occur in the KMC analysis area.
Kaibab Band of Paiute Indians	No response	None
Moapa Band of Paiute Indians	No response	None

Considerable efforts have been made by all participants to determine major issues and concerns and potential effects the Proposed Action may have on federally listed threatened, endangered, proposed, and candidate species. At the project kickoff meeting for the cooperating agencies, a Biological Resources Working Group (later renamed the ESA Section 7/Biological Resources [ESA/Bio] Subgroup) was formed with representatives from Reclamation, OSMRE, BIA, U.S. Environmental Protection Agency, USFWS, Hopi Tribe, Navajo Nation, and AECOM. The project applicants and their contractors including EPRI, Environ, and Logan Simpson, also participated in the ESA/Bio Subgroup by contributing expertise and background data and analyses to assist in evaluation of impacts including air quality monitoring and risk assessments. Other agencies added to the ESA/Bio Subgroup over time included the U.S. Geological Survey, National Park Service, and BLM.

Informal consultation with the USFWS has been ongoing. This process has helped (1) identify which species and habitats may be in the action area, (2) determine the effects that the Proposed Action may have on listed species, (3) discuss ways the effects can be eliminated or reduced through modification of the Proposed Action, (4) discuss the need to enter into formal consultation, and (5) discuss ways the Proposed Action can contribute to the conservation of selected listed species. ESA/Bio Subgroup meetings were held frequently during the period of time leading up to submitting the Draft EIS and Draft BA.

In total, 27 meetings/conference calls of the ESA/Bio Subgroup (including meetings of the closely related and overlapping Ecological Risk Assessment [ERA] Subgroup) were held between June 2013 and January 2016. The purpose of these meetings included requests for information on special status species in the project area, updates on agency activities related to the BA and biological resource sections of the EIS, interagency review of the final species list and outline for the BA, presentation of Mojave and Sonoran desert tortoise habitat assessments, review of ERA planning efforts and background data, and presentation of ERA field sampling results and the preliminary results of the ERAs for baseline conditions and the action alternatives. Additional agency coordination meetings and calls were held with the Navajo Nation, Hopi Tribe, USFS, and BLM to discuss issues and exchange information specific to those tribes and agencies. Several meetings among subsets of the ESA/Bio Subgroup were held to discuss specific aspects of the ESA section 7 consultation process. For instance, there were five meetings/calls among agency fish biologists to identify and refine fish conservation measures to be carried forward in the EIS and BA as part of the Proposed Action.

All data collected from the federal agencies, the tribes, and state and local government agencies, as described in **Table 7-3**, have been incorporated into this EIS and/or the BA, as appropriate. The BA has been completed and submitted to the USFWS. Formal consultation will begin with the USFWS determines the consultation package (i.e., the BA and supporting documentation) to be complete. In addition to the BA, a Biological Evaluation is being prepared for the Navajo Nation to address Navajo Nation-listed endangered species not covered in the BA.

7.1.3.2 Cultural Resources

Section 106 of the NHPA requires Reclamation and the cooperating federal agencies to consider the effects of the agencies' undertakings on properties listed in or eligible for the National Register of Historic Places (which can include a diversity of archaeological, historical, and traditional cultural resources). Regulations for Protection of Historic Properties (36 Code of Federal Regulations Part 800) implement Section 106 and define a process for federal agencies to use in consulting with State Historic Preservation Officers, Tribal Historic Preservation Officers, and other interested parties as they assess the effects of their undertakings. Pursuant to those regulations, Reclamation initiated Section 106 consultations with the Navajo Tribal Historic Preservation Officer and the Arizona, Nevada, and Utah State Historic Preservation Officers in May 2013. A formal letter inviting Tribes and state preservation offices to participate in the Section 106 process and the development of a proposed KMC PA were sent in July and August 2013. On July 24, 2015, Reclamation sent letters to 26 tribes (including the Navajo, Hopi, and Zuni) to provide them information about the project area and to ask if they wanted to participate in the Section 106 consultations and development of the NGS PA.

Reclamation has coordinated closely with the Navajo Nation, Hopi Tribe, and Pueblo of Zuni about various aspects of the Proposed Action, including potential impacts on cultural resources. Informational meetings were held with representatives of the Navajo Nation and Hopi Tribe as early as May 2013 and have continued regularly through the present. Information meeting were held with representatives of the Pueblo of Zuni as early as December 2013 and have continued regularly through the present.

Reclamation invited representatives from 10 Non-governmental Organizations to listening sessions on November 19 and 20, 2014, where they could provide a statement; a court reporter was available to record the statements word-for-word. Over the course of two days, 15 individuals provided comments.

Two listening sessions were held on Black Mesa at the Kayenta Mine on July 16, 2015 and August 28, 2015 for residents within and adjacent to the proposed KMC. Topics discussed included cultural resources.

A Cultural Resources Subgroup was created to share information project progress and consultation activities. Participants included the Office of Surface Mining Reclamation and Enforcement, Bureau of Indian Affairs, AECOM and Statistical Research, Inc., SRI Foundation, SRP, PWCC, and specific subcontractors conducting archaeological and ethnographic studies (HDR, Inc.; Anthropological Research, LLC; Logan Simpson). The group was organized to coordinate compliance with NHPA Section 106, and other laws, regulations, and ordinances protecting cultural resources; to facilitate completion of Ethnographic Assessments for the NGS-KMC Project EIS, and manage data collection activities. The subcommittee members reviewed the cultural resources study plan and technical reports. Cultural Resources Subgroup meetings were generally held monthly to update participants on project activities and progress.

7.1.3.2.1 Cultural Resources Update Meeting (CRUM):

Three public meetings were held to provide agency staff and the interested public regarding progress in preparing Programmatic Agreements in compliance with Section 106 of the NHPA. **Table 7-4** presents a summary of the CRUM meetings.

Table 7-4 Summary of Cultural Resources Update Meetings

Date	Agencies/Entities represented
October 30, 2013	Bureau of Reclamation, OSMRE, BIA, BLM, USFS, NPS, Arizona SHPO, SRP, PWCC, APS, Navajo Nation, Hopi Tribe, Pueblo of Zuni, Museum of Northern Arizona, Statistical Research, Inc., SRI Foundation, plus 25 public members including representatives of Black Mesa Trust.
May 15, 2014	Bureau of Reclamation, OSMRE, BIA, USFS, ACHP, NPS, Arizona SHPO, Utah SHPO, APS, SRP, PWCC, Navajo Nation, Hopi Tribe, Pueblo of Zuni, Statistical Research, Inc., SRI Foundation, plus 4 public members including a representative of Black Mesa Conservancy.
December 2, 2014	Reclamation, OSMRE, BIA, ACHP, Arizona SHPO, Utah SHPO, SRP, PWCC, APS, Hopi Tribe, Pueblo of Zuni, Hualapai Tribe, Statistical Research, Inc., SRI Foundation, HDR, plus public members including representatives of Black Mesa Conservancy Black Mesa Trust, Black Mesa Water Coalition, Forgotten Navajo People.

7.1.4 Air Quality Subgroup

Activities focused on air quality-related components of the proposed action and alternatives, including emissions, ambient impacts, and other air quality-related topics. The group also reviewed the atmospheric deposition components of trace metals and acid compounds that were used for the Ecological Risk Assessment and Human Health Risk Assessment prepared to support the EIS.

Air quality subgroup participants included federal agency staff from Reclamation, the Office of Surface Mining Reclamation and Enforcement, Bureau of Indian Affairs, Environmental Protection Agency, National Park Service, Fish and Wildlife Service, Forest Service, and Bureau of Land Management; AECOM; Salt River Project; and Peabody Western Coal Company. At times, specific contractors who supported technical work prepared to support the EIS process participated in the interactions, related to review of their technical work products.

Interactions by the Air Quality Subgroup included conference calls, meetings, and webinars where data and reports were presented and discussed; technical documentation and modeling results were reviewed; and discussions occurred related to how the data were to be integrated into the EIS process. The subgroup activities, scheduled and coordinated on an as-needed basis, continued through the preparation of the Preliminary Draft EIS.

7.2 Public Review of the Draft EIS

A Notice of Availability and Notice of Public Meetings for the Draft Environmental Impact Statement for the Navajo Generating Station-Kayenta Mine Complex Project, Arizona was published in the Federal Register on September 30, 2016, by the Bureau of Reclamation, Interior. Written comments on the Draft EIS should be submitted on or before Tuesday, November 29, 2016.

7.2.1 Distribution List of the Draft EIS

Federal Agencies

Advisory Council on Historic Preservation, Washington, DC
Bureau of Indian Affairs, Washington, DC
Bureau of Indian Affairs - Trust Services, Washington, DC
Bureau of Indian Affairs - Navajo Regional Office, Gallup, NM (Cooperating Agency)
Bureau of Indian Affairs - Western Regional Office, Phoenix, AZ (Cooperating Agency)
Bureau of Indian Affairs - Western Regional Office, Phoenix, AZ
Bureau of Indian Affairs - Western Regional Office, Phoenix, AZ
Bureau of Indian Affairs - Hopi Agency, Keams Canyon, AZ
Bureau of Indian Affairs - Hopi Agency, Hotevilla, AZ
Bureau of Indian Affairs - Pima Agency, Sacaton, AZ
Bureau of Indian Affairs - Salt River Agency, Scottsdale, AZ
Bureau of Land Management, Washington, DC (Cooperating Agency)
Bureau of Land Management, Arizona State Office, Phoenix, AZ
Bureau of Land Management - Nevada State Office, Reno, NV
Bureau of Land Management - Utah State Office, Salt Lake City, UT
Bureau of Land Management - Phoenix District Office, Phoenix, AZ
Bureau of Reclamation, Office of the Commissioner, Washington, DC
Bureau of Reclamation - Lower Colorado Regional Office, Boulder City, NV
Bureau of Reclamation - Upper Colorado Regional Office, Salt Lake City, UT
Council on Environmental Quality, Washington, DC
Indian Health Service, Navajo Area, Window Rock, AZ
Indian Health Service, Rockville, MD
National Park Service - Glen Canyon, Page, AZ (Cooperating Agency)
National Park Service, Grand Canyon National Park, Grand Canyon, AZ
National Park Service, Mesa Verde, CO
National Park Service, Intermountain Regional Office, Denver, CO
National Park Service, Intermountain Regional Office, Lakewood CO
National Park Service, Phoenix, AZ
Office of Surface Mining Reclamation and Enforcement, Denver, CO (Cooperating Agency)
U.S. Fish and Wildlife Service, Washington, DC
U.S. Fish and Wildlife Service, Southwest Region 2, Albuquerque, NM
U.S. Fish and Wildlife Service - Arizona Ecological Services, Phoenix, AZ (Cooperating Agency)*
U.S. Fish and Wildlife Service, New Mexico Ecological Services Field Office, Albuquerque, NM
U.S. Geological Survey - Environmental Affairs Program Office, Denver, CO
U.S. Geological Survey - Rocky Mountain Area, Flagstaff, AZ
U.S. Geological Survey - Arizona Water Science Center Tucson, AZ
U.S. Department of the Interior, Office of Environmental Policy and Compliance, Washington, DC
U.S. Department of the Interior, Office of Environmental Policy and Compliance, Denver, CO
U.S. Department of the Interior, Office of Environmental Policy and Compliance, San Francisco, CA
U.S. Department of the Interior, Office of the Solicitor, Albuquerque, NM
U.S. Department of the Interior, Office of the Solicitor, Lakewood, CO

U.S. Department of the Interior, Office of the Solicitor, Salt Lake City, UT
U.S. Department of the Interior, Office of the Solicitor, Phoenix Field Office, Phoenix, AZ
U.S. Army Corps of Engineers, Los Angeles District, Regulatory Division, Los Angeles, CA
U.S. Army Corps of Engineers, Arizona Regulatory Branch, Phoenix, AZ
U.S. Department of Commerce, Washington, DC
U.S. Department of Energy, Washington, DC
U.S. Department of Justice, U.S. Attorneys' Office, District of Arizona, Phoenix, AZ
U.S. Department of Labor, Mine Safety and Health Administration, Denver, CO
U.S. Environmental Protection Agency - Federal Activities Office, Washington, DC
U.S. Environmental Protection Agency, Region 9, San Francisco, CA (Cooperating Agency)*
USDA Forest Service - Southwest Region, Albuquerque, NM (Cooperating Agency)
USDA Forest Service - Kaibab National Forest, Cameron, AZ
USDA Forest Service - Kaibab National Forest, Williams, AZ
USDA Forest Service - Prescott National Forest, Prescott, AZ
USDA Natural Resource Conservation Service, Washington, DC
Western Area Power Administration - Desert Southwest Region, Phoenix, AZ

Elected Officials - Federal (Arizona)

Farrington, Shari, Office of Congressman Trent Franks, Glendale, AZ
Flake, Jeff, U.S. Congress, Phoenix, AZ
Franks, Trent, U.S. House of Representatives, 8th District, Glendale, AZ
Gallego, Ruben, U.S. House of Representatives, 7th District, Phoenix, AZ
Gosar, Paul, U.S. House of Representatives, 4th District, Prescott, AZ
Grijalva, Raul, U.S. House of Representatives, 3rd District, Tucson, AZ
Kirkpatrick, Ann, U.S. House of Representatives, 1st District, Flagstaff, AZ
Knight, Kevin, Office of Congressman David Schweikert, Scottsdale, AZ
McCain, John, U.S. Congress, Phoenix, AZ
McSally, Martha, U.S. House of Representatives, 2nd District, Tucson, AZ
Salmon, Matt, U.S. House of Representatives, 5th District, Gilbert, AZ
Schweikert, David, U.S. House of Representatives, 6th District, Scottsdale, AZ
Sinema, Kyrsten, U.S. House of Representatives, 9th District, Phoenix, AZ

Elected Officials - Federal (Utah)

Chaffetz, Jason, U.S. House of Representatives, 3rd District, Provo, UT
Hatch, Orrin, U.S. Congress, Salt Lake City, UT
Lee, Mike, U.S. Congress, Salt Lake City, UT

Native American Tribes

Andrews, Malinda, Hopi Tribe of Arizona, Tribal Council, Kykotsmovi, AZ
Bahnimptewa, Anita, Hopi Tribe of Arizona, Tribal Council, Kykotsmovi, AZ
Bates, Lorenzo, Navajo Nation Council, Window Rock, AZ
Beauty, Thomas, Yavapai Apache Nation of Camp Verde Indian Reservation, Arizona, Camp Verde, AZ

Begay, Jr., Kee Allen, Navajo Nation Council, Window Rock, AZ

Begay, Norman M., Navajo Nation Council, Window Rock, AZ

BeGaye, Nelson S., Navajo Nation Council, Window Rock, AZ

Begaye, Russell, President, Navajo Nation, Window Rock, AZ (Cooperating Agency)

Bennett, Benjamin, Navajo Nation Council, Window Rock, AZ

Bow, Corrina, Paiute Indian Tribe of Utah (Cedar, Kanosh, Koosharem, Indian Peaks, and Shivwits Bands), Cedar City, UT

Brown, Nathaniel, Navajo Nation Council, Window Rock, AZ

Burdette, Vivian, Tonto Apache Tribe of Arizona, Payson, AZ

Burnette, Bernadine, Fort McDowell Yavapai Nation, Arizona, Fountain Hills, AZ

Chee, Tom, Navajo Nation Council - Shiprock Chapter, Window Rock, AZ

Counts, Sherry J., Hualapai Indian Tribe of the Hualapai Indian Reservation, Arizona, Peach Springs, AZ

Crotty, Amber Kanazbah, Navajo Nation Council, Window Rock, AZ

Damon, Seth, Navajo Nation Council, Window Rock, AZ

Daniels, Jr., Herman, Navajo Nation Council, Window Rock, AZ

Dongoske, Kurt, Pueblo of Zuni - Zuni Heritage and Historic Preservation Department Office, Zuni, NM

Elmer, Michael, Hopi Tribe of Arizona, Tribal Council, Kykotsmovi, AZ

Filfred, Davis, Navajo Nation Council, Window Rock, AZ

Fredericks, Bruce, Hopi Tribe of Arizona, Tribal Council, Kykotsmovi, AZ

Frost, Clement, Southern Ute Indian Tribe, Ignacio, CO

Gillon, Robert*, Pascua Yaqui Tribe, Attorney General's Office, Tucson, AZ

Glassco, Greg, Yavapai Prescott Indian Tribe, Prescott, AZ

Hale, Jonathan, Navajo Nation Council, Window Rock, AZ

Hart, Manuel, Ute Mountain Ute Tribe, Towaoc, CO

Honani, Rosa, Hopi Tribe of Arizona, Tribal Council, Kykotsmovi, AZ

Honanie, Antone, Hopi Tribe of Arizona, Tribal Council, Kykotsmovi, AZ

Honanie, Herman*, Chairman, Hopi Tribe of Arizona, Tribal Council, Kykotsmovi, AZ

Honanie, Norman, Hopi Tribe of Arizona, Tribal Council, Kykotsmovi, AZ

Hopi Department of Natural Resources, Kykotsmovi, AZ

Hopi Tribe of Arizona, Hopi Cultural Preservation Office, Kykotsmovi, AZ

Hopi Tribe of Arizona, Office of Mining and Minerals, Kykotsmovi, AZ

Hopi Tribe of Arizona, Office of Realty Service, Kykotsmovi, AZ

Hopi Tribe of Arizona, Tribal Council, Kykotsmovi, AZ

Hopi Tribe of Arizona, Wildlife and Ecosystems, Kykotsmovi, AZ

Jack, Sr., Lee, Navajo Nation Council, Window Rock, AZ

Jackson-Kelly, Loretta, Hualapai Indian Tribe of the Hualapai Indian Reservation, Arizona, Peach Springs, AZ

Jones, Sr., Ernest, Yavapai Prescott Indian Tribe, Prescott, AZ

Kaping, Miona, Hopi Tribe of Arizona, Tribal Council, Kykotsmovi, AZ

Keevama, Lamar, Hopi Tribe of Arizona, Tribal Council, Kykotsmovi, AZ

Kewanimptewa, Ruth, Hopi Tribe of Arizona, Tribal Council, Kykotsmovi, AZ

Kootswatewa, Norene, Hopi Tribe of Arizona, Tribal Council, Kykotsmovi, AZ

Kuwanhyoima, Wayne, Hopi Tribe of Arizona, Tribal Council, Kykotsmovi, AZ

Lomahquahu, Jr., Alfred, Vice Chairman, Hopi Tribe of Arizona Kykotsmovi, AZ

Lupe, Ronnie, White Mountain Apache Tribe of the Fort Apache Reservation, Arizona, Whiteriver, AZ

Maldonado, Roland, Kaibab Band of Paiute Indians of the Kaibab Indian Reservation, Arizona, Fredonia, AZ

Manuel, Edward, Tohono O'odham Nation - Schuk Toak District, Sells, AZ

Miguel, Robert, Ak-Chin Indian Community, Maricopa, AZ

Navajo Nation Aneth Chapter, Montezuma Creek, UT

Navajo Nation Beclabito Chapter, Shiprock, NM

Navajo Nation Birdsprings Chapter, Winslow, AZ

Navajo Nation Black Mesa Chapter, Pinon, AZ

Navajo Nation Blue Gap/Tachee Chapter, Blue Gap, AZ

Navajo Nation Bodaway-Gap Chapter, Gap, AZ

Navajo Nation Cameron Chapter, Cameron, AZ

Navajo Nation Chilchinbeto Chapter, Kayenta, AZ

Navajo Nation Chinle Chapter, Chinle, AZ

Navajo Nation Coalmine Canyon Chapter, Tuba City, AZ

Navajo Nation Coppermine Chapter, Page, AZ

Navajo Nation Cornfields Chapter, Ganado, AZ

Navajo Nation Cove Chapter, Red Valley, AZ

Navajo Nation Crystal Chapter, Navajo, NM

Navajo Nation Dennehotso Chapter, Dennehotso, AZ

Navajo Nation Department of Agriculture, Window Rock, AZ

Navajo Nation Department of Fish and Wildlife, Window Rock, AZ

Navajo Nation Department of Justice, Window Rock, AZ

Navajo Nation Department of Water Resources, Fort Defiance, AZ

Navajo Nation Dilkon Chapter, Winslow, AZ

Navajo Nation Division of Natural Resources, Window Rock, AZ

Navajo Nation Environmental Protection Agency, Window Rock, AZ

Navajo Nation Forest Lake Chapter, Pinon, AZ

Navajo Nation Fort Defiance Chapter, Fort Defiance, AZ

Navajo Nation Ganado Chapter, Ganado, AZ

Navajo Nation Greasewood Springs Chapter, Ganado, AZ

Navajo Nation Hardrock Chapter, Kykotsmovi, AZ

Navajo Nation Historic Preservation Office, Window Rock, AZ

Navajo Nation Hogback Chapter, Shiprock, NM

Navajo Nation Houck Chapter, Houck, AZ

Navajo Nation Indian Wells Chapter, Indian Wells, AZ

Navajo Nation Jeddito Chapter, Keams Canyon, AZ

Navajo Nation Kaibeto Chapter, Kaibeto, AZ

Navajo Nation Kayenta Chapter, Kayenta, AZ

Navajo Nation Kinlichee Chapter, St. Michaels, AZ

Navajo Nation Klagetoh Chapter, Ganado, AZ
Navajo Nation LeChee Chapter, Page, AZ
Navajo Nation Leupp Chapter, Leupp, AZ
Navajo Nation Low Mountain Chapter, Keams Canyon, AZ
Navajo Nation Lukachukai Chapter, Lukachukai, AZ
Navajo Nation Many Farms Chapter, Many Farms, AZ
Navajo Nation Mexican Springs Chapter, Tohatchi, NM
Navajo Nation Mexican Water Chapter, Teecnospos, AZ
Navajo Nation Naschitti Chapter, Sheepsprings, NM
Navajo Nation Navajo Mountain Chapter, Tonalea, AZ
Navajo Nation Nazlini Chapter, Nazlini, AZ
Navajo Nation Newcomb Chapter, Newcomb, NM
Navajo Nation Oak Springs Chapter, Window Rock, AZ
Navajo Nation Oljato Chapter, Monument Valley, UT
Navajo Nation Pinon Chapter, Pinon, AZ
Navajo Nation Red Lake Chapter, Navajo, NM
Navajo Nation Red Mesa Chapter, Montezuma Creek, UT
Navajo Nation Red Valley Chapter, Red Valley, AZ
Navajo Nation Rock Point Chapter, Rock Point, AZ
Navajo Nation Rough Rock Chapter, Chinle, AZ
Navajo Nation Round Rock Chapter, Round Rock, AZ
Navajo Nation San Juan Chapter, Fruitland, NM
Navajo Nation Sanostee Chapter, Sanostee, NM
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AVRA Water Co-op, Inc., Tucson, AZ
Chaparral City Water Company, Fountain Hills, AZ
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Rio Verde Utilities, Inc., Rio Verde, AZ
Salt River Project, Phoenix, AZ
Spanish Trail Water Company, Tucson, AZ
The Carefree Water Company, Carefree, AZ
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Flowing Wells Irrigation District, Tucson, AZ
Harquahala Valley Irrigation District, Tonopah, AZ
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Maricopa-Stanfield Irrigation and Drainage District, Maricopa, AZ
McMicken Irrigation District, Waddell, AZ
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Chapter 8.0

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8.0 List of Preparers 8-1
8.1 List of Preparers 8-1

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Glossary

Glossary

A

Acceleration of Gravity. 32 feet per second squared (9.8 meters per second squared).

Acre-foot/acre-feet. A unit for measuring the volume of water equal to the quantity of water required to cover one acre to a depth of one foot and is equal to 43,560 cubic feet or 325,851 gallons. The term is commonly used in measuring volumes of water used or stored.

Affected Environment. A NEPA term that refers to a description of the environment of the area(s) to be affected or created by the alternatives under consideration. The description must include baseline information to create a basis for assessing or understanding the impacts that would result from implementation of the alternatives. It must contain enough detail to support the impact analyses and highlight environmentally sensitive resources (e.g., floodplains, wetlands, threatened and endangered species, and archeological resources).

Air Model. A mathematical simulation of how air pollutants disperse in the ambient atmosphere.

Air Pollutant. Generally an airborne substance that could, in high enough concentrations, harm living things or cause damage to materials. From a regulatory perspective, an air pollutant is a substance for which emissions or atmospheric concentrations are regulated and for which maximum guideline levels have been established due to potential harmful effects on human health and welfare.

Air Quality. The cleanliness of the air as measured by the levels of pollutants relative to standards or guideline levels established to protect human health and welfare.

Alternative: A NEPA term that refers to a way of achieving the same purpose and need for a project that is different from the recommended proposal; alternatives should be studied, developed, and described to address any proposal which involves unresolved conflicts concerning different uses of available resources. Analysis scenarios presented in a comparative form, to facilitate a sharp definition of the issues resulting in a basis for evaluation among options by the decision maker and the public.

Ambient. The environment as it exists at the point of measurement and against which changes or impacts are measured.

Aquatic Bird. Wading, swimming, and diving birds, such as waterfowl, shorebirds, seabirds, and rails.

Aquatic. Occurring in, or closely associated with, water.

Aquifer. A body of rock that is sufficiently permeable to conduct groundwater and yield economically significant quantities of water to wells, springs, sands, and soils.

Archaeological Resource. “Any material remains of past human life or activities of archaeological interest...” These “include, but are not limited to: pottery, basketry, bottles, weapons, projectiles, tools, structures or portions of structures, pit houses, rock paintings, rock carvings, intaglios, graves, human skeletal materials, or any portion or piece of any of the foregoing items. Non-fossilized and fossilized paleontological specimens, or any portion or piece thereof, shall not be considered archaeological resources unless found in an archaeological context. No item shall be treated as an archaeological resource unless such item is at least 100 years of age.” (Archaeological Resource Protection Act of 1979, as amended, 16 USC 470bb(1))

Archaeological Site. A geographic locale that contains the material remains of prehistoric or historic human activity.

Archaeology. The reconstruction of past cultures through their material remains and the study of how cultures change over time.

Area of Critical Environmental Concern (ACEC). An area approved through a land use plan where special management attention is required to protect and prevent irreparable damage to important biological, cultural, historic, or scenic values, or other natural systems or processes, or to protect humans from natural hazards.

Artesian head. The distance in a well (feet, meters) that groundwater under pressure is able to rise above the level at which it is first encountered when the well taps the aquifer. The pressure in such an aquifer commonly is called artesian pressure, and the formation containing artesian water is an artesian, or confined, aquifer.

Assumptions (for analysis). The basis for framing the analysis. Assumptions often are identified at the beginning of the environmental consequences section of an EA or EIS and, as needed, at the beginning of the program-specific environmental consequences analysis.

Attainment Area. An area that the U.S. Environmental Protection Agency has designated as being in compliance with one or more of the National Ambient Air Quality Standards (NAAQS) for sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, lead, and particulate matter. An area may be in attainment for some pollutants but not for others (see National Ambient Air Quality Standards (NAAQS), nonattainment area).

Avian. Relating to birds.

B

Bald and Golden Eagle Protection Act. A law that prohibits the take, possession, selling, purchasing, bartering, or transporting of live or dead bald or golden eagles, or any parts, nests, or eggs of these birds.

Baseline. The existing environmental conditions against which impacts of the proposed action and its alternatives can be compared. For a specific NEPA document, a further statement can be included about the date or conditions that are considered the baseline.

Best Available Control Technology (BACT). Available devices, systems, or techniques for achieving the maximum reduction of air pollutant emissions while considering energy, environmental, and economic impacts. BACT is determined on a case-by-case basis for new sources or major modifications to existing sources in areas that are in attainment of NAAQS. BACT does not permit emissions in excess of those allowed under any Clean Air Act provisions. (See Lowest Achievable Emissions Rate [LAER], Maximum Achievable Control Technology [MACT], Reasonably Achievable Control Technology [RACT], and National Ambient Air Quality Standards [NAAQS].)

Best Available Retrofit Technology (BART). An emission limitation to reduce regional haze, based on the degree of reduction achievable through the application of the best system of continuous emission reduction for each pollutant which is emitted by an existing stationary facility. The emission limitation must be established, on a case-by-case basis, taking into consideration the technology available, the costs of compliance, the energy and non-air quality environmental impacts of compliance, any pollution control equipment in use or in existence at the source, the remaining useful life of the source, and the degree of improvement in visibility which may reasonably be anticipated to result from the use of such technology. (40 CFR 51.301)

Best Management Practices (BMPs). A practice or combination of practices that are the most effective and practical means of preventing or reducing the amount of environmental impact, including but not limited to, pollution generated by nonpoint sources to a level compatible with water quality goals.

Big Game. Large animals that may be taken by hunters, pursuant to local government restrictions and regulations.

Bituminous Coal. A rank class of coal defined as having less than 86 percent fixed carbon, more than 14 percent volatile matter on a dry, mineral-matter-free basis, and from 10,500 to 14,00 British thermal units (Btu's) per pound on a moist, mineral-matter-free basis.

C

Candidate Species. An ESA term that refers to a plant or animal species for which the USFWS or NOAA Fisheries has on file sufficient information on biological vulnerability and threats to support a proposal to list as endangered or threatened.

Categorical Exclusion (CE). A NEPA term, referring to a category of actions that do not individually or cumulatively have a significant effect on the human environment and have been found to have no such effect in procedures adopted by a Federal agency pursuant to NEPA.

Chemical of Potential Concern (COPC) or Chemical of Potential Ecological Concern (COPEC). A chemical that is potentially site related and of sufficient quality to quantify risk. Chosen primarily on the basis of an evaluation of the chemical analytical data and relationship of measured levels to background levels. COPC is typically used for human health risk assessments and COPEC is used for ecological risk assessments.

Class I Area. A specifically designated area where the degradation of air quality is stringently restricted (e.g., many national parks, wilderness areas). (See Prevention of Significant Deterioration.)

Climate. The average or prevailing weather conditions of a place over a lengthy period of years (Bureau of Land Management Technical Reference 4400-7).

Colorado River Compact of 1922. Provides for the equitable division and apportionment of the use of the waters of the Colorado River System between the Upper Basin states (Colorado, New Mexico, Utah, and Wyoming) and the Lower Basin states (Arizona, California, and Nevada).

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). A Federal law (also known as Superfund), enacted in 1980 and reauthorized in 1986, that provides the legal authority for emergency response and cleanup of hazardous substances released into the environment and for the cleanup of inactive waste sites.

Conservation Agreement. An ESA term referring to a voluntary agreement between FWS or NOAA Fisheries and other federal or non-federal landowners to identify specific conservation measures that the participants of the agreement will undertake to conserve species covered by the agreement, none of which are listed under the Endangered Species Act, with the intention of preventing any need to list the species.

Consumptive Use. The portion of water withdrawn from a surface water or groundwater source that is consumed for a particular use (i.e., irrigation, domestic needs, and industry), and does not return to its original source or another body of water.

Cooperating Agency. A NEPA term, referring to any Federal agency, other than a lead agency, that has jurisdiction by law or special expertise with respect to any environmental impact involved in a proposed project or project alternative. A State or local agency of similar qualifications or, when the effects are on lands of tribal interest, a Native American tribe may, by agreement with the lead agencies, also become a cooperating agency

Corona. The electrical breakdown of air into charged particles caused by the electrical field at the surface of conductors, insulators, and hardware of energized high-voltage transmission lines.

Council on Environmental Quality (CEQ). Established under Title II of NEPA to develop Federal agency-wide policy and regulations for implementing the procedural provisions of NEPA, resolve interagency disagreements concerning proposed major Federal actions, and ensure that Federal agency programs and procedures are in compliance with NEPA.

Criteria Pollutant. An air pollutant that is regulated by NAAQS. The Environmental Protection Agency must describe the characteristics and potential health and welfare effects that form the basis for setting, or revising, the standard for each regulated pollutant. Criteria pollutants include sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, lead, and two size classes of particulate matter, less than 10 micrometers (0.0004 inch) in diameter, and less than 2.5 micrometers (0.0001 inch) in diameter. Pollutants may be added to, or removed from, the list of criteria pollutants as more information becomes available. (See National Ambient Air Quality Standards.) Note: Sometimes pollutants regulated by state laws also are called criteria pollutants.

Critical Habitat (threatened and endangered species). As used by the ESA, the specific areas within the geographical area occupied by the species that contain those physical or biological features essential to the considerations or protection, and specific areas outside the geographical area occupied by the species, that are essential for the conservation of the species.

Crucial Range. Can describe any particular seasonal range or habitat component (often winter or year-long range in the project area) but describes that component which has been documented as the determining factor in a population's ability to maintain itself at a certain level (theoretically at or above the state wildlife agency population objective) over the long term.

Cultural Property. A definite location of past human activity, occupation, or use identifiable through field inventory (survey), historical documentation, or oral evidence (BLM Manual 8100).

Cultural Resources. A general term meaning any cultural property and any traditional lifeway value (BLM Manual 8100). It includes prehistoric, historic, ethnographic, tribal heritage, ethnohistoric, engineering, architectural, and technological resources.

<u>Cultural Resources Investigations</u>

Class I (Files Search) Inventory. A file search completed to identify all previously conducted cultural resources investigations and previously recorded cultural resources within a defined distance (typically 1 mile) on either side of proposed rights-of-way, roads, and other project facilities.

Class II Inventory. A reconnaissance-level Inventory typically combined with a Class I Inventory. Class II is usually used as a methodology in large scale projects for locating areas with good or better cultural resources potential to determine whether previously recorded cultural resources exist within the proposed project area, and to determine whether portions of the project area have been adequately surveyed in the recent past.

Class III (Pedestrian) Inventory. A Class III intensive field inventory to locate and record cultural resources and places of traditional, cultural, and religious importance to Native Americans.

Cumulative Effect/Cumulative Impact. As used by NEPA, the impact or impacts that result from identified actions when they are added to other past, present, and reasonably foreseeable future actions regardless of who undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time.

D

dBA. An "A" weighting is commonly used when sound is measured in decibels. It emphasizes vibrations at middle frequencies where the human ear is most sensitive, and puts less emphasis on higher and lower frequencies to which the ear is not sensitive.

Decommissioning. Removal of project facilities at the end of their operational life.

Desiccation cracks. Cracks that form in clayey soils because of low moisture content.

Designated Wilderness. See Wilderness.

Dispersed Recreation. Passive or active outdoor recreation that occurs outside of developed sites in an unconcentrated manor.

Drawdown. The lowering of the water level in a well, spring, or waterbody as a result of water withdrawal in another area; the reduction in head at a point caused by the withdrawal of water from an aquifer.

Drawdown Contour. A boundary derived from water modeling that depicts a certain reduction in the water level compared to its previous level.

E

Earnings. Wages and salaries, other labor income, and proprietor's income (including inventory valuation and capital consumption adjustments).

Ecological Resources. Animals, plants, and the habitats in which they live.

Ecological System. All the organisms in a particular region and the environment in which they live. The elements interact with each other in some way, and so depend on each other either directly or indirectly.

Ecology. The science of the interrelationships between organisms and their environment.

Effluent. A waste stream flowing into the atmosphere, surface water, groundwater, or soil. Most frequently the term applies to wastes discharged to surface waters.

Electromagnetic Fields (EMF). A combination of electric and magnetic fields of energy that surround any electrical devise that is plugged in and turned on. EMFs are found near powerlines and other electronic devices.

Endangered Species Act (ESA) of 1973, as amended. Federal legislation intended to provide a means to conserve the ecosystems upon which endangered and threatened species depend, and which provides programs for the conservation of those species, thus preventing extinction of plants and animals.

Endangered Species. Any species defined through the Endangered Species Act of 1973, as amended, as being in danger of extinction throughout all or a significant portion of its range; designations of endangered species are published in the Federal Register.

Endemic Species. Species native to, and restricted to, a particular geographical region, community type, or specific habitat; generally used for species with comparatively restricted distribution.

Environmental Assessment (EA). A NEPA term, which refers to a concise public document that a federal agency prepares under the National Environmental Policy Act to provide sufficient evidence and analysis to determine whether a proposed action requires preparation of an Environmental Impact Statement (EIS) or whether a Finding of No Significant Impact can be issued. An EA must include brief discussions on the need for the proposal, the alternatives, the environmental impacts of the proposed action and alternatives, and a list of agencies and persons consulted.

Environmental Consequences. Environmental effects of project alternatives, including the proposed action, which cannot be avoided; the relationship between short-term uses of the human environment, and any irreversible or irretrievable commitments of resources which would be involved if the proposal should be implemented.

Environmental Impact Statement (EIS). A NEPA term, referring to a formal document that is filed with the U.S. Environmental Protection Agency and that considers significant environmental impacts expected to result from implementation of a major federal action.

Environmental Justice. The fair treatment of people of all races, cultures, incomes, and educational levels with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

F

Fault. A fault is a dislocation in the earth whereby there is movement along a fracture with the movement on either side of the fracture parallel to the plane of the fracture. An active fault is a fault that movement has occurred within the last 10,000 years. A Quaternary fault is a fault that that has moved within the last 1.6 million years.

Federal Register. The official daily publication for rules, proposed rules, and notices of federal agencies and organizations, as well as executive orders and other presidential documents.

Firming. A secondary source of energy to compensate for the normal variability and irregularity of renewable energy generation (e.g., if part of a solar array is shaded by cloud cover) in order to assure delivery of a specific quantity of energy during a defined period of time.

Fissures or Earth Fissures. Cracks that form as a result of the lowering of groundwater levels in unconsolidated aquifer materials such as valley fill sediments that occur in parts of Arizona.

Floodplain. A nearly level alluvial plain that borders a stream and is subject to inundation under flood-stage conditions unless protected artificially. It is usually a constructional landform built of sediment deposited during overflow and lateral migration of the stream.

Forage. Plant material consumed by, or available to, grazing animals.

Fragmentation. The breaking up of contiguous areas of vegetation/habitat into smaller patches.

Fugitive Emissions. 1. Emissions that do not pass through a stack, vent, chimney, or similar opening where they could be captured by a control device. 2. Any air pollutant emitted to the atmosphere other than from a stack. Sources of fugitive emissions include pumps; valves; flanges; seals; area sources such as ponds, lagoons, landfills, piles of stored material (e.g., coal); and road construction areas or other areas where earthwork is occurring.

G

Game Species. Species of animals that are hunted or fished, for purposes of sport, recreation, and food capture.

Geographic Information System (GIS). A computer system capable of storing, analyzing, and displaying data and describing places on the earth's surface.

Greenhouse Gas. Gases which absorb outgoing terrestrial radiation, such as water vapor, methane, chlorofluorocarbons, and carbon dioxide.

Groundwater. Subsurface water that is in the zone of saturation. The top surface of the groundwater is the "water table." Source of water for wells, seepage, springs.

H

Habitat Edges. Changes in vegetation and animal communities that are caused by one habitat type being immediately adjacent to a different habitat type. Habitat edges can include changes in temperature, humidity, and plan and wildlife species present in the area.

Habitat. An environment that meets a specific set of physical, biological, temporal, or spatial characteristics that satisfy the requirements of a plant or animal species or group of species for part or all of its life cycle.

Hazardous Air Pollutants (HAPs). Air pollutants not covered by the National Ambient Air Quality Standards but which may present a threat of adverse human health effects or adverse environmental effects. Those specifically listed in 40 CFR 61.01 are asbestos, benzene, beryllium, coke oven emissions, inorganic arsenic, mercury, radionuclides, and vinyl chloride. More broadly, HAPs are any of the 189 pollutants listed in or pursuant to section 112(b) of the Clean Air Act. Very generally, HAPs are any air pollutants that may realistically be expected to pose a threat to human health or welfare.

Hazardous Waste. A category of waste regulated under the Resource Conservation and Recovery Act (RCRA). To be considered hazardous, a waste must be a solid waste under RCRA and must exhibit at least one of four characteristics described in 40 CFR 261.20 through 40 CFR 261.24 (i.e., ignitability, corrosivity, reactivity, or toxicity) or be specifically listed by the Environmental Protection Agency in 40 CFR 261.31 through 40 CFR 261.33. Source, special nuclear, or by-product materials as defined by the Atomic Energy Act are not hazardous waste because they are not solid waste under RCRA.

Heavy Metals. Metallic and semimetallic elements that are generally highly toxic to plants and animals and that tend to accumulate in food chains. Heavy metals include lead, mercury, cadmium, chromium, and arsenic. . EPA regulation 40 CFR 258.4 refers to the following monitoring parameters as "heavy metals": antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, nickel, selenium, silver, thallium, vanadium, and zinc. Note: The term "heavy metals" is deeply embedded in environmental usage and will doubtless continue to be used. However, some of the elements commonly called "heavy metals" are not heavy (e.g., beryllium) or are not true metals (e.g., arsenic). Therefore, "heavy metals" should be avoided whenever more precise wording can be substituted.

Historic Property. "…any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places maintained by the Secretary of the Interior. The term includes, for purposes of these regulations, artifacts, records, and remains that are related to and located within such properties." (36 CFR 800.16 (l)(1))

Human Health Risk Assessment (HHRA). The process used to estimate the nature and probability of adverse health effects in humans who may be exposed to hazards in contaminated environmental media, now or in the future.

Hydrologically Connected. Areas where the groundwater is linked and flow is contiguous.

I

Impact. An impact has both space and time components and can be described as the change in an environmental factor or characteristic over a specific period and within a defined area. The change results from a particular activity compared with the situation which would have occurred had the activity not been initiated. An impact may be beneficial or adverse.

Indian Trust Assets. Lands, natural resources, or other assets held in trust or restricted against alienation by the United States for Native American Tribes or individual Native Americans.

Indian Trust Resources. Those natural resources, either on or off Indian lands, retained by or reserved by or for Indian Tribes through treaties, statutes, judicial decisions, and Executive Orders, which are protected by a fiduciary obligation on the part of the United States.

Indigenous. Living naturally within a given area and part of the area's flora or fauna prior to human settlement of the region.

Indirect Effect. A NEPA term that refers to effects caused by the Federal action that are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth-inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems.

Intermittent Stream. A stream which carries water a considerable portion of the time, but which ceases to flow occasionally or seasonally because bed seepage and evapotranspiration exceed the available water supply.

J

Jurisdictional Wetlands. Those wetlands protected by the Clean Water Act. They must have a minimum of one positive wetland indicator from each parameter (i.e., vegetation, soil, and hydrology). The U.S. Army Corps of Engineers requires a permit to fill or dredge jurisdictional wetlands.

K

Key Observation Point. An observer position on a travel route used to determine visible area.

L

Land Use Plan. A land use plan is a public document that sets aside different areas for different uses, and describes what activities are permitted or not, and any limitations or conditions associated with such use.

Lead Agency. The agency or agencies responsible for preparing the environmental impact statement.

Lowest Achievable Emission Rate (LAER). The emissions rate permitted for new sources or major modifications of existing sources in areas that are not in attainment of NAAQS. The LAER is defined on a case-by-case basis, according to the regulations found in 40 CFR 51.165.

Low-Income Population. Low-income populations, defined in terms of Bureau of the Census annual statistical poverty levels (Current Population Reports, Series P-60 on Income and Poverty), may consist of groups or individuals who live in geographic proximity to one another or who are geographically dispersed or transient (such as migrant workers or Native Americans), where either type of group experiences common conditions of environmental exposure or effect.

M

Major Federal Action. A NEPA term referring to an action with effects that may be major and which is potentially subject to Federal control and responsibility (40 CFR 1508.18).

Maximum Achievable Control Technology (MACT). Technology for achieving the maximum control of air emissions from major sources of hazardous air pollutants, using particularly stringent control devices, as prescribed in 40 CFR 63.41 for new sources and in 40 CFR 63.51 for existing sources.

Migration Routes. Important areas used by wildlife to connect seasonal habitats.

Migratory Bird Treaty Act. A law enacted in 1918 that prohibits pursuing, hunting, taking, capturing, killing, possessing, selling, bartering, purchasing, delivering, transporting, and receiving any migratory birds, parts, nests, or eggs.

Migratory Bird. A bird that moves seasonally to different ranges to maximize breeding and feeding opportunities.

Minority Population. Minority populations exist where either: (a) the minority population of the affected area exceeds 50 percent or (b) the minority population percentage of the affected area is meaningfully greater than in the general population or other appropriate unit of geographic analysis (such as a governing body's jurisdiction, a neighborhood, census tract, or other similar unit). "Minority" refers to individuals who are members of the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic. "Minority populations" include either a single minority group or the total of all minority persons in the affected area. They may consist of groups of individuals living in geographic proximity to one another or a geographically dispersed/transient set of individuals (such as migrant workers or Native Americans), where either type of group experiences common conditions of environmental exposure or effect.

Mitigate, Mitigation. 1) Avoiding or reducing possible adverse impacts to a resource by limiting the timing, location, or magnitude of an action and its implementation; 2) rectifying possible adverse impact by repairing, rehabilitating or restoring the affected environment or resource; 3) reducing or eliminating adverse impacts by preservation and maintenance operations during the life of an action.

Mitigation Measure. A measure or action taken to reduce the adverse impacts to the environment from implementation of a project or another action. Such measures may include avoidance, replacement, restoration, relocation, timing of operations, etc.

Monitoring. The periodic observation and orderly collection of data to evaluate: 1) Effects of management actions; and 2) effectiveness of actions in meeting management objectives (43 Code of Federal Regulations 4100.0.5). The orderly collection, analysis, and interpretation of resource data to evaluate progress toward meeting management objectives. (BLM Technical Reference 4400-7).

N

National Ambient Air Quality Standards (NAAQS). The allowable concentrations of air pollutants in the ambient (public outdoor) air. National ambient air quality standards are based on the air quality criteria and divided into primary standards (allowing an adequate margin of safety to protect the public health) and secondary standards (allowing an adequate margin of safety to protect the public welfare).

National Emissions Standards for Hazardous Air Pollutants (NESHAPs). Emissions standards set by the Environmental Protection Agency for air pollutants which are not covered by NAAQS and which may, at sufficiently high levels, cause increased fatalities, irreversible health effects, or incapacitating illness. These standards are found in 40 CFR Parts 61 and 63. NESHAPs are given for many specific categories of sources (e.g., equipment leaks, industrial process cooling towers, dry cleaning facilities, petroleum *refineries*).

National Environmental Policy Act of 1969 (NEPA). A Federal environmental law that established a U.S. national policy promoting the enhancement of the environment; also established the President's Council on Environmental Quality (CEQ). NEPA's most significant effect was to set up procedural requirements for all federal government agencies to prepare Environmental Assessments (EAs) and Environmental Impact Statements (EISs) containing statements of the environmental effects of proposed federal agency actions.

National Historic Preservation Act (NHPA). A federal law providing that property resources with significant national historic value be placed on the National Register of Historic Places. It does not require permits; rather, it mandates consultation with the proper agencies whenever it is determined that a proposed action might affect a historic property.

National Monument. An area designated to protect objects of scientific and historic interest by public proclamation by the President (under the Antiquities Act of 1906) or by Congress for historic landmarks, historic, and prehistoric structures, or other objects of historic or scientific interest situated upon the public lands and to provide for the management of associated features and/or values.

National Pollutant Discharge Elimination System (NPDES). A program authorized by the Clean Water Act which prohibits discharge of pollutants into waters of the United States unless a special permit is issued by the Environmental Protection Agency, a state, or, where delegated, a tribal government on an Indian reservation. The NPDES permit lists either permissible discharges, the level of cleanup technology required for wastewater, or both.

National Recreation Area. An area designated by Congress in order to assure the conservation and protection of certain natural, scenic, historic, pastoral, and fish and wildlife values and to provide for the enhancement of associated recreational values.

National Register of Historic Places. A register of districts, sites, buildings, structures, and objects, significant in American history, architecture, archaeology and culture, established by the National Historic Preservation Act and maintained by the Secretary of the Interior.

Native American. Of, or relating to, a tribe, people, or culture that is indigenous to the United States.

Native Species. With respect to a particular ecological system, a species that, other than as a result of an introduction, historically occurred or currently occurs in that ecological system.

Natural Recharge. Replenishment of groundwater storage from naturally-occurring surface water sources such as rain, snow-melt, or stream flows.

No Action Alternative. A NEPA term that refers to the alternative in which the proposed Federal action is not taken (40 CFR 1502.14(d)). For many Federal actions, the No Action Alternative represents a scenario in which current conditions and trends are projected into the future without another proposed action, such as updating a land management plan. In other cases, the No Action Alternative represents the future in which the Federal action does not take place and the project is not implemented. In the case of the Navajo Generating Station-Kayenta Mine Complex Project, under the No Action Alternative, the power plant would cease operation, the plant lease would not be renewed, and the Kayenta Mine permit revision application would not be approved.

Nonattainment Area. An area that the U.S. Environmental Protection Agency has designated as not meeting (i.e., not being in attainment of) one or more of the National Ambient Air Quality Standards (NAAQS) for sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, lead, and particulate matter. An area may be in attainment for some pollutants, but not for others. (See attainment area, National Ambient Air Quality Standards [NAAQS], and particulate matter.)

Nongame Species. Those wildlife species that are not legally hunted.

Notice of Intent (NOI). A notice published in the *Federal Register* that an environmental impact statement will be prepared and considered.

O

Obligate Phreatophyte. Plants which typically require access to groundwater at shallow soil depths for the majority of the year.

Occupational Safety and Health Administration (OSHA). The main federal agency charged with enforcement of safety and health legislation.

P

Paleontological Resources. Any fossilized remains, traces, or imprints of organisms, preserved in or on the earth's crust, that are of paleontological interest and that provide information about the history of life on earth (P.L. 111-011).

Paleontology. The study of past life on earth through the preservation and classification of fossils (naturally preserved remains or impressions of organisms).

Particulate matter (PM), PM_{10}, $PM_{2.5}$. Any finely divided solid or liquid material, other than uncombined (i.e., pure) water. A subscript denotes the upper limit of the diameter of particles included. Thus, PM_{10} includes only those particles equal to or less than 10 micrometers (0.0004 inch) in diameter; $PM_{2.5}$ includes only those particles equal to or less than 2.5 micrometers (0.0001 inch) in diameter. Note: The applicable regulations express the diameter as the aerodynamic diameter. This is not the true diameter, but is the diameter of a spherical particle of unit density (i.e., 1 gram/cubic centimeter) which behaves the same way as the particle under consideration. Thus, for example, a spherical particle 10 micrometers in diameter with greater than unit density would not be included as PM_{10} because it would fall at the same rate as a particle with unit density and diameter greater than 10 micrometers.

Perennial Springs. A spring in which water is present during all seasons of the year.

Perennial Stream. A stream in which water is present during all seasons of the year.

Perennial Yield (sometimes also referred to as sustainable yield). The amount of usable water from a ground-water aquifer that can be economically withdrawn and consumed each year for an indefinite period of time. It cannot exceed the natural recharge to that aquifer and ultimately is limited to a maximum amount of discharge that can be utilized for beneficial use.

Permeability. The quality of the soil that enables water to move downward through the profile, measured as the number of inches per hour that water moves downward through the saturated soil.

Phase I Environmental Site Assessment (ESA). A Phase I ESA is an inquiry conducted to determine if contamination by hazardous substances as defined by CERCLA is present at a particular property. A Phase I ESA inquiry is conducted under standards developed by the American Society for Testing and Materials (ASTM) and USEPA rules. A Phase I ESA involves site inspection, records review, and interviews with knowledgeable persons to determine whether current and past uses of a property indicate the potential presence of contamination. Phase I ESA's are primarily conducted by prospective buyers or lenders pursuant to transactions or lending involving real property in order to provide the basis of the "innocent landowner" defense under CERCLA. If a Phase I ESA indicates the potential for contamination, a Phase II ESA may be conducted to verify the presence of contamination. The Phase II ESA may involve the sampling and testing of soil, water, and other media.

Piezometric Surface. The imaginary surface to which groundwater rises under hydrostatic pressure in wells. It is an imaginary or hypothetical surface of the pressure (or artesian) head throughout all or part of a confined or semi-confined aquifer; analogous to the water table of an unconfined aquifer.

Plume. The elongated volume of contaminated water or air originating at a pollutant source such as an outlet pipe or a smokestack. A plume eventually diffuses into a larger volume of less contaminated material as it is transported away from the source.

Potential Fossil Yield Classification System (PFYC). A system used by some federal agencies to classify geologic units based on the relative potential of valuable vertebrate fossils or scientifically important invertebrate or plant fossils. PFYC has fossil potential classes that range from one (the lowest potential) to five (the highest potential).

Prevention of Significant Deterioration (of air quality) (PSD). Regulations established to prevent significant deterioration of air quality in areas that already meet NAAQS. Specific details of PSD are found in 40 CFR 51.166. Among other provisions, cumulative increases in sulfur dioxide, nitrogen dioxide, and PM-10 levels after specified baseline dates must not exceed specified maximum allowable amounts. These allowable increases, also known as increments, are especially stringent in areas designated as Class I areas (e.g., national parks, wilderness areas) where the preservation of clean air is particularly important. All areas not designated as Class I are currently designated as Class II. Maximum increments in pollutant levels are also given in 40 CFR 51.166 for Class III areas, if any such areas should be so designated by EPA. Class III increments are less stringent than those for Class I or Class II areas.

Programmatic Agreement. A document that records the terms and conditions agreed upon to resolve the potential adverse effects of a Federal agency program, complex undertaking or other situations in accordance with 36 CFR 800.14(b).

Proponents. The non-Federal sponsors of a proposed project or undertaking that requires a Federal action. For the Navajo Generating Station-Kayenta Mine Complex Project, the proponents are Salt River Project Agricultural Improvement and Power District (SRP), which is the operating agent of the NGS, and Peabody Western Coal Company (PWCC), which is the owner/operator of the Kayenta Mine.

Proposed Action. A NEPA term referring to a plan that contains sufficient details about the intended actions to be taken, or that will result, to allow alternatives to be developed and its environmental impacts analyzed.

Public Health. The science of protecting the safety and improving the health of communities through education, policy making and research for disease and injury prevention.

Public Scoping. A NEPA term referring to discussions with and disclosure to agencies and the public with regard to a project or undertaking wherein areas of concern or issues to be addressed in a NEPA document are determined. (See Scope and Scoping.)

Pumping Effects. Any impact to natural or man-made resources that can be directly attributed to groundwater pumping.

Q

R

Raptor. A bird of prey that feeds upon smaller animals.

Reasonably Achievable Control Technology (RACT). Technology for control of air pollutant emissions from existing sources in areas that are not in attainment of NAAQS. RACT may include devices, systems, process modifications, or other apparatus or techniques that are reasonably achievable taking into account: (1) the necessity of imposing such controls in order to attain and maintain an NAAQS; (2) the social, environmental, and economic impact of such controls; and (3) alternative means of providing for attainment and maintenance of such a standard.

Reclamation. The process by which lands disturbed as a result of human activity are restored by grading, planting, seeding, etc., to stabilize the disturbed area and simulate original conditions.

Record of Decision. A NEPA term which refers to a document separate from but associated with an environmental impact statement (EIS) that publicly and officially discloses the responsible agency's decision on the EIS alternative to be implemented.

Regional Air Quality. The measure in the outdoor atmosphere of one or more contaminants such as dust, fumes, gas, mist, odor, smoke, or vapor.

Regional Haze. Visibility impairment that is caused by the emission of air pollutants from numerous sources located over a wide geographic area. Such sources include, but are not limited to, major and minor stationary sources, mobile sources, and area sources. (40 CFR 51.301)

Reserve Power. The electrical energy required for Central Arizona Project pumping requirements, which is currently approximately two-thirds of the United States' 24.3 percent interest in the power and energy generated at NGS.

Resource Conservation and Recovery Act (RCRA). A law that gives the U.S. Environmental Protection Agency the authority to control hazardous waste from "cradle to grave" (i.e., from the point of generation to the point of ultimate disposal), including its minimization, generation, transportation, treatment, storage, and disposal. RCRA also sets forth a framework for the management of non-hazardous solid wastes.

Resource Management Plan. A Bureau of Land Management multiple-use planning document, prepared in accordance with Section 202 of the Federal Land Policy and Management Act, that:

- Establishes resource conditions goals and objectives to be attained;
- Allocates resources and identifies allowable uses;
- Identifies land area for limited, restrictive, or exclusive uses; and
- Provides guidance for implementation of the decisions made in the plan.

Revegetation. The reestablishment and development of self-sustaining plant cover.

Richter Scale or Richter Magnitude Scale. The Richter scale is used to estimate the magnitude of earthquakes. It is a base-ten logarithmic scale that has largely been replaced with other scales by researchers, but is still used to communicate earthquake magnitudes to the public.

Riparian Communities/Areas. Vegetation communities that occur adjacent to waterways such as streams, rivers, springs, ponds, lakes, or tidewater and that provide habitat for numerous plant and animal species. They generally occupy transitional areas between aquatic and upland habitats and may function as vegetative buffers for aquatic resources.

Runoff. Surface water, from rain, snow melt, or other sources, that flows off the surface of the land without sinking into the soil. The precipitation discharged into stream channels from an area.

S

Sacred Landscapes. Natural places recognized by a cultural group as having spiritual or religious significance.

Sacred Site. Any specific, discrete, narrowly delineated location of federal land that is identified by an Indian tribe, or individual determined to be an appropriately authoritative representative of an Indian religion, as sacred by virtue of its established religious significance to, or ceremonial use by, an Indian religion; provided that the tribe or appropriately authoritative representative of an Indian religion has informed the agency of the existence of such a site (Executive Order 13007, Section 7 1[b][iii]).

Scope. The range of actions, alternatives, and impacts to be considered in an EA or EIS.

Scoping. An early and open process for determining the extent and variety of issues to be addressed and for identifying the significant issues related to a proposed action that should be evaluated in an EA or EIS.

Scoria (clinker). Rock that has been baked or melted because of the burning of adjacent coal seams.

Section 7 of the Endangered Species Act. Describes the responsibilities of Federal agencies in conserving threatened and endangered species.

Seep. Wet areas, normally not flowing, arising from an underground water source.

Significant. Use of this term in NEPA requires consideration of both context and intensity (40 CFR 1508.27): Context - significance of an action must be analyzed in its current and proposed short-and long-term effects on the whole of a given resource (e.g.-affected region) Intensity – Refers to the severity of the effect.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. For example, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Small Game. Small animals that may be taken by hunters, pursuant to local government restrictions and regulations.

Socioeconomics. The social and economic conditions in the study area.

Special Status Species. Plant or animal species that are federally listed, proposed, or Bureau of Land Management or USFS sensitive species.

Species. A group of interbreeding individuals not interbreeding with another such group; similar and related species are grouped into a genus.

Spring. Flowing water originating from an underground source.

State Historic Preservation Officer (SHPO). The State official appointed or designated pursuant to section 101(b)(1) of the National Historic Preservation Act to administer the State historic preservation program. (36 CFR 800.16 (v))

Study Area. The physical extent of a resource as related to the area of the proposed project.

Subbituminous Coal. A rank class of coal that has a heating value that ranges from 8,300 to 10,500 Btu's per pound on a moist, mineral-matter-free basis.

Subsidence. Lowering of the land surface that can be caused by natural or anthropogenic-caused processes.

Surface Water. All bodies of water on the surface of the earth and open to the atmosphere, such as rivers, lakes, reservoirs, ponds, seas, and estuaries.

Surplus Power. The electrical energy from the United States' share of NGS power that is excess to that used by the Central Arizona Project. This surplus power is sold at market rates with the revenues being deposited to the Lower Basin Development Fund.

Syncline. A syncline is a geologic fold structure where the strata have been folded downward.

T

Technical Work Group (TWG). A stakeholder group formed by SRP, comprised of DOI, Gila River Indian Community, Navajo Nation, Salt River Project, Environmental Defense Fund, Central Arizona Water Conservation District, and Western Resource Advocates. The TWG developed an alternative to U.S. Environmental Protection Agency's proposed BART for NGS, and submitted it for U.S. Environmental Protection Agency's consideration.

Terrestrial. Relating to land; a land animal.

Threatened Species. Any plant or animal species defined under the Endangered Species Act of 1973 as likely to become endangered within the foreseeable future throughout all or a significant portion of its range. Requirements for declaring a species threatened are contained in the Endangered Species Act of 1973; listings are published in the Federal Register.

Topography. The form and structure of the land surface.

Traditional Cultural Property. A cultural property that derives significance from traditional lifeway values associated with it. A traditional cultural property may qualify for the National Register if it meets the criteria and criteria exceptions at 36 Code of Federal Regulations 60.4.

Traditional Use. A term referring to a category that is applied to any cultural resource known to be perceived by a specified social and/or cultural group as important in maintaining the cultural identity, heritage, or well-being of the group. Cultural properties assigned to this category are to be maintained in ways that recognize the importance ascribed to them and seek to accommodate their continuing traditional use.

Tribal Historic Preservation Officer (THPO). The tribal official appointed by the tribe's chief governing authority or designated by a tribal ordinance or preservation program who has assumed the responsibilities of the SHPO for purposes of section 106 compliance on tribal lands in accordance with section 101(d)(2) of the National Historic Preservation Act. (36 CFR 800.16 (w))

Tribal Lands. In the Native American Graves Protection and Repatriation Act, tribal land is defined as: (a) all lands within the exterior boundaries of any Indian reservation; (b) all dependent Indian communities; and (c) any lands administered for the benefit of Native Hawaiians pursuant to the Hawaiian Homes Commission Act, 1920, and section 4 of Public Law 86-3. In the National Historic Preservation Act, tribal land is defined as: (a) all lands within the exterior boundaries of any Indian reservation; and (b) all dependent Indian communities.

U

Unavoidable Adverse Effects. Effects that cannot be avoided due to constraints in alternatives. These effects do not have to be avoided by the planning agency, but they must be disclosed, discussed, and mitigated, if practicable.

Unconformity. A geological surface that represents missing strata that either was not deposited or was eroded.

U.S. Fish and Wildlife Service (USFWS). 1940 reorganization plan (54 Stat. 1232) in the Department of the Interior consolidated the Bureau of Fisheries and the Bureau of Biological Survey into one agency to be known as the Fish and Wildlife Service. The Bureau of Sport Fisheries and Wildlife was created as a part of the U.S. Fish and Wildlife Service in the Department of the Interior on November 6, 1956, by the Fish and Wildlife Act of 1956 (70 Stat. 1119). That act was amended on July 1, 1974, by Public Law 93-271 (88 Stat. 92) to, among other purposes, abolish the position of Commissioner of Fish and Wildlife and designate the Bureau as the U.S. Fish and Wildlife Service.

V

Vegetation Communities. A combination of dominant plant species that live together in the same region or on the same landform.

Visual Resource Management Classes. A classification of landscapes according to the kinds of structures and changes that are acceptable to meet established visual goals.

Visual Resources. The visible physical features of a landscape (topography, water, vegetation, animals, structures, and other features) that constitute the scenery of an area.

W

Water Right. A legal entitlement of an individual or entity to extract water from a water source (surface water or groundwater) and to use it for a beneficial use (e.g., potable water supply, irrigation, mining, livestock).

Watershed. 1) A total area of land above a given point on a waterway that contributes runoff water to the flow at that point; 2) A major subdivision of a drainage basin.

Wetlands. Areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soils

Wilderness. An area designated by Congress and defined in Section 2(c) of the Wilderness Act of 1964 as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain. An area of wilderness is further defined as an area of undeveloped federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which: 1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; 2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; 3) has at least 5,000 acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and 4) also may contain ecological, geological, or other features of scientific, educational, scenic, or historical values.

Wind Rose. A circular diagram showing, for a specific location, the percentage of the time the wind is from each compass direction. A wind rose for use in assessing consequences of airborne releases also shows the frequency of different wind speeds for each compass direction.

X

Xeric. An environment or habitat that is extremely dry, lacking humidity and water.

Y

Z

Zone of Saturation. The area in an aquifer, below the water table, in which relatively all pores and fractures are saturated with water. Also called the phreatic zone, it may fluctuate with changes of season and during wet and dry periods. Multiple zones of saturation may occur below any given point on the surface.

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Index

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Index

A

- Air Quality (also see Emissions), 3.1-1
  - Criterial Pollutants, 3.1-48
  - Major Sources, 3.1-7
  - Modeling, 3.1-22, 3.1-30
  - Monitoring, Regional, 3.1-6
  - Deposition, 3.0-24, 3.0-30; 3.1-13, 3.1-15, 3.1-33, 3.1-44
    - Airborne, 3.7-119
    - Atmospheric, 3.1-13
    - Metals, 3.1-33
  - Regional, 3.1-6
- Aquatic Biological Resources, 3.12-1
  - Amphibians, 3.12-12
  - Invertebrates, 3.12-11
  - Non-native Fish Species, 3.12-8
  - Special Status Aquatic Species, 3.13-1
    - Bluehead Sucker, 3.13-61
    - Bonytail, 3.13-8, 3.13-41, 3.13-69, 3.13-80
    - Colorado Pikeminnow, 3.13-11, 3.13-43, 3.13-63, 3.13-69, 3.13-80
    - Desert Pupfish, 3.13-30, 3.13-63, 3.13-78
    - Flannelmouth Sucker, 3.13-61
    - Gila Chub, 3.13-64, 3.13-78
    - Gila Topminnnow, 3.13-32, 3.13-64, 3.13-78
    - Humpback Chub, 3.13-18, 3.13-50, 3.13-72, 3.13-81
    - Kanab Ambersnail, 3.13-27, 3.13-60
    - Loach Minnow, 3.13-33, 3.13-65, 3.13-78
    - Northern Leopard Frog, 3.13-62, 3.13-77
    - Razorback Sucker, 3.13-22, 3.13-65, 3.13-74, 3.13-81
    - Roundtail Chub, 3.13-34, 3.13-65, 3.13-78
    - Selenium, 3.13-45, 3.13-55, 3.13-57, 3.13-58, 3.13-70, 3.13-73, 3.13-76
    - Speckled Dace, 3.13-61
    - Spikedace, 3.13.35, 3.13-65, 3.13-78
    - Tissue Concentrations, 3.13-45, 3.13-55, 3.13-57, 3.13-58
    - Virgin River Chub, 3.13.35, 3.13-66, 3.13-78
    - Woundfin, 3.13-36, 3.13-66, 3.13-78
- Aquifer, 3.7-11
  - Alluvial, 3.7-33, 3.7-71
  - C-Aquifer, 3.7-13
  - Configuration, 3.7-15
  - D-Aquifer, 3.7-26
    - Spring flows, 3.7-59
    - Springs, 3.7-29
    - Uses, 3.7-64
    - Water Quality, 3.7-27
    - Water Use, 3.7-27
    - Well Yields, 3.7-26
  - N-Aquifer, 3.7-3, 3.7-5, 3.7-13
    - Spring flows, 3.7-59
    - Pumping on springs, seeps, and stream baseflows, 3.7-119
    - Springs, 3.7-29

    - Study Area, 3.7-6, 3.7-20
    - Supply Wells, 3.7-23
    - Water Levels, 3.7-49
    - Water Use, 3.7-25
    - Well Withdrawals, 3.7-25
    - Withdrawals, 3.7-50
  - Wepo Aquifer, 3.7-67
  - R-Aquifer, 3.7-13
  - Drawdown, 3.7-52, 3.7-53
  - Flow Reductions, 3.7-56
  - Perched Water, 3.7-18, 3.7-46
  - Aquifer Relationships, 3.7-11
- Affected Environment, 3.0-3
  - Scope of Analysis, 3.0-1
  - Direct Effects, 3.0-1
  - Cumulative Impacts; 3.0-1, 3.0-2, 3.0-7
  - Issues, 3.0-7
  - Regulatory Framework, 3.0-2
  - Study Areas, 3.0-2
  - Surface Disturbance, 3.0-2, 3.0-4
- Alternatives, 2-1, 2-2
  - Comparison of Alternatives, 3.0-20
  - Natural Gas PFR Alternative, 2-28, 2-36
  - No Action, 2-39Proposed Action, 1-1, 1-7
  - Partial Federal Replacement, 2-28
  - Renewable PFR Alternative, 2-31
  - Tribal PFR Alternative, 2-34
- Ash Disposal (see Coal Combustion Residuals [CCR])

B

- Best Management Practices, 4-1
- Biological Resources – Formal Consultation, 7-5
- Black Mesa, 3.3-1, 3.3-2
- Black Mesa Mine (see Former Black Mesa Mine)

C

- Central Arizona Project, 1-8, 3.18-44
  - Affected Tribes, 3.18-44, 3.18-45
  - Finances, 3.18-48
  - Operations, 3.18-48
  - Water Delivery, 3.18-49
- Clean Water Act, 3.7-2, 3.7-3
- Climate Change, 3.2-1, 3.2-2
  - Precipitation, 3.5-5, 3.2-7
  - Trends, Regional, 3.2-8
  - Temperature, 3.2-5, 3.2-6
  - Water Supply, 3.2-10
- Coal Combustion Residual (CCR), 3.14-4
  - Coal Ash Disposal, 1-29, Appendix 1B, 1-29
  - Coal Combustion Residual Rule, 1-29
  - Ash Disposal, 3.14-4
  - Fly Ash, 1-29
  - Groundwater, 3.7-44
  - Landfill, 1-28, 1-29

Closure and Post-closure Activities, 3.7-46
Coal Resource Areas, 1-12, 1-14
Consultation and Coordination, 7-1
Cooperating Agencies, 1-22
Co-tenants, NGS, 1-3
Co-tenancy Agreement, 1-10
Cultural Resources, 3.17-1
Archaeological Cultural Resources, 3.17-31
Archaeological Resources, 3.17-24, 3.17-26, 3.17-34, 3.17-37, 3.17-39
Architectural Resources, 3.17-33, 3.17-37, 3.17-39, 3.17-40
Cultural-environmental Areas, 3.17-17
Cultural History, 3.17-17, 3.17-19
Data Collection, 3.17-14
Data Quality Assessment Survey, 3.17-30
Federally Recognized Tribes, 3.17-17, 3.17-24
Formal Consultation, 7-7
Historic Properties, 3.17-31
Human Burials, 3.17-33
Programmatic Agreements, 3.17-7
Traditional Cultural Properties, 3.17-26, 3.17-33, 3.17-37, 3.17-39, 3.17-41

D

Decommissioning, 1-43, 2-17, 2-23
Deposition (see Air Quality)

E

Economic Conditions, 3.18-10, 3.18-46
Agriculture, 3.18-46
Community Development, 3.18-26
Employment Status, 3.18-10, 3.18-12
Income Characteristics, 3.18-11
Labor Force, 3.18-10
Poverty, 3.18-10
Emissions, 3.1-1
Acid Deposition, 3.1-13, 3.1-54
Criterial Pollutants, 3.1-48
Deposition, 3.1-48
Key Assumptions, NGS, 3.1-21
Navajo Generating Station (NGS), 3.1-28
Proposed Kayenta Mine Complex (KMC), 3.1-36
Transmission System, 3.1-45
Modeling, 3.1-4 3.1-22, 3.1-39
Far Field, 3.1-4, 3.1-5
Near Field, 3.1-4, 3.1-5
AERMOD, 3.1-30
National Ambient Air Quality Standards, (NAAQS), 3.1-1, 3.1-2
NGS, 3.1-28
Ozone, 3.1-51, 3.1-52
Proposed KMC, 3.1-36
Regional Haze, 3.1-4, 3.1-11, 3.1-27, 3.1-35, 3.1-51
Regional Emissions Sources, 3.0-9
Emissions and Deposition, 3.8-21, 3.8-25, 3.8-27, 3.8-29, 3.8-31, 3.8-32
Airborne Deposition, Surface Water, 3.7-48
Environmental Consequences, 3.0-5

- Assumptions and Impact Methodology, 3.0-5
- Proposed Action, 3.0-5
- Impact Magnitude, 3.0-6
  - Biological Assessment Effect Determinations, 3.0-7

Environmental Justice
- Impact Methodology, 3.19-5
- Indirect Effects – Central Arizona Project, 3.19-15
- Issues, 3.19-5
  - Air Quality, 3.19-7, 3.19-10
  - Cultural Resources, 3.19-9, 3.19-12
  - Hazardous Materials, 3.19-8, 3.19-11
  - Human Health, 3.19-8, 3.19-11
  - Water Resources, 3.19-7, 3.19-10
  - Public Health, 3.19-8, 3.19-11
  - Socioeconomic Conditions, 3.19-9, 3.19-12
- Populations
  - Low Income, 3.19-4
  - Minority, 3.19-3
  - Public Participation – Low Income and Minority, 3.19-8

Past and Present Actions, 3.0-8

Reasonably Foreseeable Future Actions, 3.0-8

F

Federal Actions, 1-15 to 1-20,
- Biological Opinion, 1-17
- Biological Evaluation,
- Cultural Resources, 1-16, 1-18
- Clean Water Act, 1-17, 1-18,
- Clean Air Act, 3.1-1
  - National Ambient Air quality Standards (NAAQS), 3.1-1, 3.1-2
  - Hazardous Air Pollutants (HAPs), 3.1-3
  - Mercury and Air Toxics Standards Rule, 3.1-3
- ESA Section 7 consultation, 1-16
- Federal Land Policy and Management Act, 1-17
- Government-to-government Consultation, 1-16, 1-17, 1-18,1-19, 7-1
- National Pollution Discharge Elimination System, 1-18
- Resource Recovery and Reclamation Act, 1-17
- Right-of-Way (ROW), 1-15, 1-16, 1-17, 1-18, 1-19, 1-20
- U.S. Environmental Protection Agency Actions, 1-47

Former Black Mesa Mine Facilities, 1-36, 1-46

G

Glen Canyon Dam, 3.7-13

Government-to-government Consultation, 7-4

Greenhouse Gases, 3.2-1, 3.2-13

Groundwater (also see Aquifer), 3.7-10
- Alluvial Water Levels, 3.7-109
- Proposed KMC, 3.7-20
- Hopi Community, 3.7-20
- Drawdown, 3.7-51
- Monitoring, 3.7-44
- Model, numerical, 3.7-50
- Model Domain, 3.7-51
- Navajo Community, 3.7-20

    Protection Plan, 3.7-18, 3.7-46
    Pumping, 3.8-25, 3.8-27, 3.8-29, 3.8-32, 3.8-35
    Quality, 3.7-18

H

Hazardous Air Pollutants (HAPS), 3.1-3
Historical Operations, 1-22
    Navajo Generating Station (NGS), 1-22
    Kayenta Mining and Mine Support Facilities, 1-33
    Former Black Mesa Mine and Mine Support Facilities, 1-45
    Transmission Systems and Communication Sites, 1-47
Hopi Tribe
    Budget, 3.18-23
    Community Development, 3.18-26
    Education, 3.18-25
    Employment
        Kayenta Mine, 3.18-38
        Navajo Generating Station, 3.18-38
    Housing, 3.18-24
    Indian Trust Assets, 3.20-3
    Population Growth, 3.18-25
    Reservation Location, 3.18-32
    Traditional Values, 3.18-42
Human Health (see Public Health and Human Health Risk Assessment [HHRA])

I

Impact Summary, 2-42
Indian Trust Assets, 3.20-1
    Cap-Affected Tribes, 3.20-4, 3.20-11
    Hopi Tribe, 3.20-3
        Hunting, 3.20-10
        Land, 3.20-9
        Minerals, 3.20-10
        Water, 3.20-9
    Kaibab Band of Paiute Indians, 3.20-3
    Moapa Band of Paiute Indians, 3.20-3
    Navajo Nation, 3.20-3
        Hunting, 3.20-8
        Land, 3.20-7
        Minerals, 3.20-8
        Water, 3.20-5
Irretrievable Commitment of Resources, 6-1
Irreversible Commitment of Resources, 6-1

J

Joint Use Navajo Mining Lease, 1-5

K

Kayenta Mine Complex (KMC), 3.1-18
- Air Quality Control and Monitoring, 1-42
- Coal Production, 3.0-19
- Community Programs, 1-43
- Economic Contributions, 3.18-20
- Initial Program Regulations, 3.14-1
- Habitation, 3.14-5
- Homesite Leases, 3.18-36
- Livestock Grazing, 3.14-5, 3.18-37
- Reclamation, Mine, 3.8-29 3.14-7, 3.18-37
  - Cultural Planting Areas, 3.14-9
  - Plant Species, 3.14-9
- Reclamation Performance Bond, 3.14-2
- Permanent Program Regulations, 3.14-1
- Pre-Law Regulations, 3.14-1
- Surface Disturbance, 3.0-20

L

Lake Powell, 3.7-13, 3.7-47
- Water Quality, 3.7-19

Land Cover, 3.8-3, 3.8-5, 3.8-8, 3.8-15

Landfill, 1-28, 1-31
  - Asbestos Landfill, 1.3-1, 3.14-4
  - Solid Waste, 1-31
  - Hazardous Waste Management, 1-31

Land Use, 3.14-1, 3.14-4, 3.14-5, 3.14-12, 3.14-15
- Agriculture, 3.14-7
- Communication Sites Location and Size, 3.14-11

Long-Term Productivity, 5-1

M

Mine Safety and Health Administration, 3.7-2

Mining Leasehold, 1-5, 1-6
- Joint Use Hopi Mining Lease, 1-5

Mitigation, 4-1, 4-2

N

Navajo Generating Station (NGS), 1-1, 1-3
- Economic Contributions, 3.18-18
- Emissions Assumptions (Air Quality), 3.1-21
- BM&LP Railroad, 1-31
- Chemical Storage and Use, 1-27
- Fuel Storage and Use, 1-27
- Landfills and Waste Management, 1-28. 3.14-4
- Operational Factors, 3.0-18
- Power Generation, 3.0-19
- Water
  - Water Supply, Intake Structure, 1-11, 3.14-4
  - Groundwater Protection, 1-27
- Wastewater Management, 1-27

Stratigraphy, 3.7-16
Navajo Mining Lease, 1-5
Navajo Nation
Budget, 3.18-23
Chapters in Project Area, 3.18-32
Education, 3.18-25
Employment, 3.8-38
Kayenta Mine, 3.18-38
Navajo Generating Station, 3.18-38
Housing, 3.18-24
Indian Trust Assets, 3.20-3
Population Growth, 3.18-25
Traditional Values, 3.18-42
Navajo Nation Safe Drinking Water Act, 3.7-2
Navajo Project Indenture of Lease for Units 1, 2, and 3 (1969 Lease), 1-9

O

Other Federal Agencies, 1-21
BIA 323 Grant, 1-9

P

Participants, NGS, 1-3
Peabody Western Coal Company
Supported Services, 3.18-33, 3.18-35, 3.18-36
Permit Area, 1-6
Plume Blight (see Regional Haze, Visibility)
Ponds, 3.7-41, 3.7-85
Quantities, 3.7-41
Water Quality, 3.7-41
Population, 3.18-6
Demographics, 3.18-6
Hopi Tribe, 3.18-7
Navajo Nation, 3.18-7
Precipitation, 3.7-9
monthly, 3.7-10
cycles, 3.7-14
Preparers, Draft EIS, 8-1
Project Area, 1-1, 1-2
Project Location, 1-8
Proposed Action, 3.0-5
Public Health and Human Health, 3.16-1, 3.16-20
Air Quality, 3.16-29
Asthma, 3.16-28
Chemicals of Potential Concern, 3.16-12, 3.16-15
Coal Dust Emissions, 3.16-32
Community Health; 3.16-3, 3.16-6
Diseases, 3.16-27
Particulate Inhalation, 3.16-22
Diesel Exhaust Emissions, 3.16-31
Demographics, 3.16-3
Land Use, 3.16-20
Population, 3.16-22
Diabetes, 3.16-28
Economy, 3.16-3, 3.16-22

Environment, 3.16-2
Heart Disease and Stroke, 3.16-27
Human Health Risk Assessment (HHRA), 3.16-1, 3.16-7
Indoor Burning of Coal and Wood, 3.16-32
Lung Cancer, 3.16-28
Public Health Evaluation, 3.16-4
Public Service/Infrastructure, 3.16-3
Risk Characterization, 3.16-13, 3.16-17
Uncertainty Analysis, 3.16-14, 3.16-18
Public Involvement, 7-1
Public Safety, 3.15-1
Hazardous Materials, 3.15-2, 3.15-7, 3.15-12, 3.15-17
Magnetic Field, 3.15-14
Noise, 3.15-1, 3.15-10
Public Safety, 3.15-1, 3.15-10
Solid Waste Disposal, 3.15-3, 3.15-8
Transportation, 3.15-7, 3.15-17
Purpose and Need, 1-1, 1-20
Reclamation, 1-20
Bureau of Indian Affairs, 1-13, 1-21
Office of Surface Management Reclamation and Control (OSMRE), 1-13, 1-21

R

Reclamation, 3.8-29
Recreation, 3.14-4, 3.14-10, 3.14-15, 3.14-17
Regional Air Quality, 3.1-47
Regional Haze, (see Emissions)
Risk Assessment, 3.0-21, 3.0-31
Ecological (ERA), 3.8-4, 3.8-7, 3.9-3, 3.10-5, 3.10-6, 3.10-7, 3.10-18, 3.10-17, 3.11-5, 3.12-4, 3.12, 10, 3.12-15, 3.12-15, 3.12-23, 3.12-36, 3.12-25, 3.12-37, 3.13-6, 3.13-16, 3.13-21
NGS Human Health (HHRA), 3.0-35; 3.16
KMC Human Health (HHRA), 3.0-35, 3.16
Study Area, 3.0-21, 3.0-22
NGS Near-field, 3.0-23, 3.0-29
San Juan River, 3.0-25, 3.0-29
Gap Regions, 3.0-25, 3.0-30, 3.10-6, 3.10-17
Proposed KMC, 3.0-25, 3.0-30, 3.10-7
Terrestrial Wildlife Receptors, 3.10-1, 3.10-5
Chemicals of Concern, 3.0-22
Hazard Index, 3.0-33
Hazard Quotient, 3.0-33
Roads, 1-41
Lease Area, 3.18-37
Navajo Route 41 Realignment, 2-23
Rivers
Colorado, 3.7-13
Basin Storage Project Act, 1-8
Compact of 1922, 1-8
Lake Powell, 3.12-8
San Juan, 3.7-13, 3.12-10, 3.12-16, 3.12-27

S

- Selective Catalytic Reduction (SCR), 3.1-27
- Scoping; 1-54
  - Summary of Issues, 1-55
- Social Cost of Carbon, 1-62, 3.2-22, 3.2-25
- Sociocultural, 3.18-27
  - Conditions and Trends, 3.18-27, 3.18-53
  - Setting, 3.18-28
  - Issues, 3.18-29
- Socioeconomics, 3.18-1
- Short Term Uses, 5-1
- Stormwater Discharges, 3.7-2
  - Multi-sector Stormwater Discharge General Permit, 3.7-3
- Study Area, 3.0-2

T

- Traditional Values, 3.18-42
- Transmission System, Southern, 3.14-15
- Transmission System, Western, 3.14-12

U

- Unemployment, 3.18-10, 3.18-12

V

- Vegetation Resources, 3.8-1
  - Cultural Planting Areas, 3.14-9
  - Federally Listed Species, 3.9-16, 3.9-17, 3.9-18, 3.9-19
  - Invasive Species, 3.8-5, 3.8-10, 3.8-19, 3.8-24
  - Riparian/Wetlands, 3.8-5, 3.8-10, 3.8-13, 3.8-24
    - Wetlands, Protection, 3.8-2
  - Southwest Regional Gap Analysis Project (SWReGAP), 3.8-5
  - Special Status Plant Species, 3.9-10
    - Brady Pincushion Cactus, 3.9-5
    - Dwarf Bear-poppy, 3.9-11
    - Fickeisen Plains Cactus, 3.9-5
    - Gierisch Mallow, 3.9-12
    - Holmgren Milk-vetch, 3.9-12
    - Jones Cycladenia, 3.9-13
    - Navajo Sedge, 3.9-7
    - NGS Special Status Plant Species, 3.9-4
    - Siler Pincushion Cactus, 3.9-14
    - Welsh's Milkweed, 3.9-6
  - Vegetation Communities, 3.8-5, 3.8-11, 3.8-23
- Visibility, 3.1-11, 3.1-35, 3.1-45
- Voluntary Commitments, 4-1

W

- Well, water, 1-27, 1-33, 1-38
  - Abandonment, 3.7-3
  - Drilling & Completion, water, 3.7-3
  - NGS Monitoring, 3.7-17
  - Production, Increase in Lift, 3.7-54, 3.7-101
  - Use, 3.7-3
  - Wellhead protection, 3.7-4
- Wastewater Treatment System Permits, 3.7-3

Water Resources, 3.7-1
  Community Demands, 3.7-98
  Management Facilities, 1-38, 1-46
  Public Water System Permit, 3.7-3
  Pumping, 3.7-105
  Surface, 3.7-13, 3.7-38
    Spring Flow, 3.7-36
    Springs and Seeps, 3.7-74
    Streamflow Quality, 3.7-39
    Streamflow Quantity, 3.7-38
    Surface Flows, 3.7-111
  Quality Standards, Tribal, 3.7-4
  Use, 1-38, 1-46
  Sampling Location, Quality, 3.7-21
  Supply Wells, 1-46, 3.0-14
    Navajo Nation and Hopi Community, 3.0-14
Weeds, Noxious, 3.8-5, 3.8-10, 3.8-19, 3.8-24
Western Transmission System (WTS), 1-7
Wildlife Resources 3.10-1
  Big Game Species, 3.10-7
    Desert Bighorn Sheep, 3.10-9
    Elk, 3.10-9
    Mule Deer, 3.10-8
    White-tailed Deer, 3.10-9
    Pronghorn, 3.10-8
  Birds of Conservation Concern, 3.10-12
    Migratory Birds, 3.10-11
    Upland Game Birds, 3.10-10
    Waterfowl, 3.10-10
  Carnivores, 3.10-9
  Candidate Species, 3.11-6, 3.11-22
  Federally Listed Species, 3.11-6, 3.11-223.11-59, 3.11-65
  Furbearers, 3.10-10
    Nongame Species, 3.10-11
    Small Game Mammals, 3.10-10
    Small Game Species, 3.10-10
  Javelina, 3.10-9
  Special Status Wildlife Resources, 3.11-1
    Black-footed Ferret, 3.11-30, 3.11-59, 3.11-65
    California Condor, 3.11-24, 3.11-30, 3.11-54, 3.11-65
    Mexican Spotted Owl, 3.11-10, 3.11-25, 3.11-32, 3.11-54, 3.11-59, 3.11-66
    Mojave Desert Tortoise, 3.11-36, 3.11-68
  Other Special Status Wildlife Species, 3.11-19, 3.11-28, 3.11-47, 3.11.56, 3.11-62, 3.11-74
    Narrow-headed Gartersnake, 3.11-43, 3.11-73
    Northern Mexican Gartersnake, 3.11-46, 3.11-74
    Sonoran Desert Tortoise, 3.11-40, 3.11-72
    Southwestern Willow Flycatcher, 3.11-14, 3.11-27, 3.11-33, 3.11-55, 3.11-60, 3.11-66
    Western Yellow-billed Cuckoo, 3.11-17, 3.11-27, 3.11-36, 3.11-55, 3.11-61, 3.11-67
  Proposed Wildlife Species, 3.11-6, 3.11-22

X, Y, Z

No entries